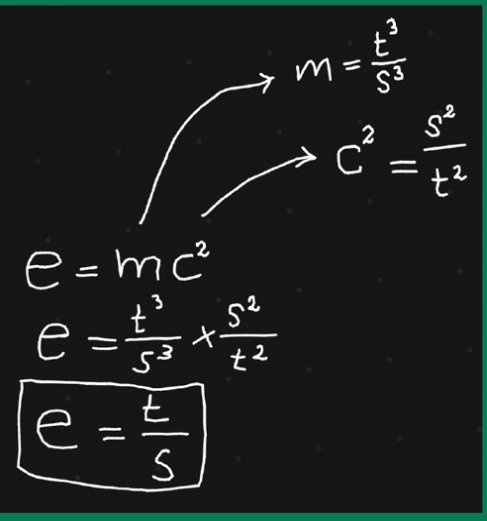
Dewey B. Larson

An Introduction



to

the

Reciprocal System

AN INTRODUCTION
TO THE
RECIPROCAL SYSTEM

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AN INTRODUCTION TO THE RECIPROCAL SYSTEM

By

DEWEY B. LARSON

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Preface

The present volume is a collection of essays and lectures by Dewey B. Larson, arranged and adapted to serve as an introduction to the Reciprocal System of Theory that he originated. It fills an urgent need, since those encountering the theory for the first time often feel overwhelmed by the novelty of its concepts and discouraged by its unfamiliar terminology. Larson was an engaging speaker and his recorded talks are both informative and entertaining. Over the years he honed his skill at presenting the basics the theory to audiences unfamiliar with his work, while reserving more advanced presentations for the annual conferences of the society devoted to its advancement. In addition, he authored numerous articles in which he reported on advances in the development of the theory.

The material represented by Larson's lectures and articles has proved to be a rich mine for extracting the components of an introductory text, suitable for those encountering the Reciprocal System for the first time. Even those familiar with Larson's major publications will find much of interest in it. In compiling a collection of this sort, it is impossible to avoid some degree of repetition, but care has been taken to keep this to a minimum.

The book opens with a critique of the current state of physical theory and its methods, then continues by laying a new foundation on which a general and consistent theory of physics can be built. This is followed by a stupendous expedition to the outer reaches of the physical universe and beyond.

The purpose of this volume will have been fulfilled if it succeeds in whetting the reader's appetite and motivating him to engage in a more systematic and in-depth study of the Reciprocal System, the only general physical theory capable of encompassing the entire range of phenomena that constitute the physical universe.

– Jan Sammer

Part I

Physics at an Impasse

CHAPTER 1

Around Unexpected Corners

Many years ago, Dr. James B. Conant, at that time president of Harvard University, gave a talk to a group of chemists and chemical executives, in which he expressed serious concern over the effect on scientific progress that was likely to result from the virtual disappearance of what he called the "uncommitted investigators," a term which he applied to those individuals who carry on scientific research work on their own initiative, without support from or direction by the established research agencies. As Dr. Conant put it, these individuals "could investigate what they pleased when they pleased, or break off research at any point. They were as free as the wind because they had no program except the ever-changing one in their own minds."

The reason for his concern, Dr. Conant explained, was that although the great majority of new discoveries in the scientific field are made by professional scientists working under the auspices of universities or research laboratories, the really revolutionary ideas, those that actually change the course of scientific progress, have come mainly from the free-wheeling activities of these *uncommitted investigators,* and if such individuals are no longer active, there is no assurance that these much-needed ideas will continue to materialize. In Dr. Conant's own words:

> The revolutionary advances in theoretical science were made very largely by amateurs… Few will deny that it is relatively easy in science to fill in the details of a new area, once the frontier has been crossed. The crucial event is turning the unexpected corner. This is not given to most of us to do. If you want advances in the basic theories of chemistry and physics in the future comparable to those of the last two centuries, then it would seem essential that there continue to be people in a position to turn unexpected corners. By definition the unexpected corner *cannot* be turned by any operation that is planned.

I have quoted the words of this distinguished member of the chemical profession at considerable length because I am about to provide a play-by-play account of a research project carried out by the kind of an individual that Dr. Conant was talking about, a member of that strange and nearly extinct species, the uncommitted investigator.

This project ultimately produced a new general physical theory. It is quite likely some may find it difficult to understand how anyone would select such an objective; how anyone in his right mind would deliberately undertake the colossal task of trying to fit all of the immense amount of scientific information that is now available into a totally new pattern. In fact, my original objective was a much more modest one, but we uncommitted investigators rarely hit where we aim. In this case, an effort originally aimed at that relatively modest objective got out of hand, so to speak, and kept on growing and turning unexpected corners until it finally produced a result that was never anticipated.

The subjects I originally selected for investigation were the physical and chemical properties of matter. These properties are essentially mathematical, although we sometimes express them in non-mathematical terms. For instance, under ordinary conditions, mercury is liquid and lead is solid, and we somewhat loosely refer to these facts as properties, but actually all that we have here is a difference in the melting point. The same is true of properties in general; that is, in the final analysis they reduce to nothing more than a set of numbers. But we also start with nothing but a set of numbers. So far as we know, the only basic difference between mercury and lead is that mercury is number 80 in the atomic series and lead is number 82. It logically follows, therefore, that if we can find the right method of approach we should be able to establish a relation between these two sets of numbers; that is, we should be able to construct a set of mathematical expressions in which we can enter the number 80 and come out with the melting point and other properties of mercury, and we can enter the number 82 and come out with the properties of lead. What I undertook to do was to see if I could find the key that would enable formulating this set of relationships.

I realized, of course, that some totally new line of attack would have to be devised if I were to have any chance of accomplishing anything of value in a field that had been combed over so often and

so thoroughly as this one, but it was my opinion that the possibilities in this respect were by no means exhausted. In fact it seemed to me that there was one whole category of possibilities that had scarcely been touched: those possibilities that are generally regarded as being too far-fetched to justify spending any time examining them.

In my home I am frequently approached by a member of the family reporting the loss of some article, along with the assertion that a careful search has been made "everywhere that it could possibly be." My response in these cases is that if this is true we must then begin to look in the places where it *cannot* possibly be, and this is where we almost invariably find the missing article.

What I proposed to do was to apply this same policy to the problem at hand; to concentrate my attention on the exploration of those ideas which have heretofore been summarily dismissed as not worthy of consideration. As I saw the situation, the desirability of this kind of an attack was particularly indicated by the strong resistance which the problem had offered to previous investigators. Experience has shown that long-continued inability to solve a basic problem nearly always indicates that some element entering into the problem is not what it appears to be. One of the actors is wearing a mask, and we don't know which one it is. Somewhere along the line that which is true is being made to appear false, because that which is false is accepted as truth.

On the strength of these considerations, I spent several years examining the consequences of ideas which at first glance seemed absurd. After long and careful consideration, that is just exactly what most of them turned out to be. They were absurd. I have no intention of ever revealing just what ideas I investigated, because, while I have a rather thick skin, it is not totally impenetrable, and some of the aspersions that would be cast on the intelligence, if not on the sanity, of anyone who would waste his time investigating such subjects would undoubtedly get through my armor plate. I am quite certain that a common reaction to item X, let us say, would go something like this, "How could anyone be so stupid as to think that there might be anything of value in that idea?" What this typical critic would fail to see is that my whole project was based on the premise that no one can tell in advance what is absurd and what is not absurd. *Before* the study was undertaken, item Y and item Z looked every bit as absurd

as item X, but Y and Z turned out to be diamonds in the rough. There were a number of such diamonds among the many worthless stones, and eventually some promising new lines of inquiry were opened up.

Work along these lines ultimately produced a number of very interesting results of a mathematical nature. According to the most influential school of modern scientific thought, this is where I should have stopped, because, these eminent scientists assert, when we know that much – that is, when we can express our knowledge mathematically – we know all there is to know about a subject. The application of this currently fashionable viewpoint to the gravitational situation is expressed by this statement that I have taken from a current textbook: "Why does a stone that is released from the hand fall to the ground? The answer is that there is a force of attraction between earth and stone for which Newton's law of gravitation holds. It does not make sense to ask further how this force of attraction comes about." I cannot subscribe to this doctrine. In fact, my suspicious nature will not even let me believe that the authors themselves really put any particular stock in it. I have noticed that this idea became popular among the physicists only *after* those physicists had tried long and hard to find the explanations that they now say are superfluous. As I mentioned in one of my publications, their present attitude reminds me of a bit of Chinese philosophy which asserts that if one cannot get what he wants, he can arrive at exactly the same end by persuading himself to want what he can get. But I am afraid that I am not a very faithful disciple of Confucius. As I see it, any purely mathematical knowledge of a physical situation is inherently incomplete and therefore not fully satisfactory. Even at the risk of being considered stubborn and unreasonable, I want some names that can be attached to the numbers. Contrary to the statement that I have just read, I believe that it does make sense to ask how and why.

So whenever I established a mathematical relation, I immediately began looking for an explanation that would account for it. One of the most intriguing of these expressions was a relation between the atomic number or numbers and the inter-atomic distance in the solid state, and this also turned out to be one of the most frustrating as well, because for a number of years I spent a very large part of my available time trying to find an explanation of this peculiar and

puzzling expression. Up to this time I had been working entirely along orthodox lines. I was examining some very strange ideas, to be sure, but that examination was being carried out within the framework of accepted scientific thought. Here is where I left the reservation. After this long period of frustration in trying to find an orthodox explanation of the mathematical relation that I was studying, it finally occurred to me that a very simple explanation would be forthcoming if I made a highly unorthodox assumption about the relation of space to time: the assumption that there is a general reciprocal relation between these two entities.

My immediate reaction to this thought was the normal one – the same reaction that almost everyone has when he first encounters the idea – a sort of an intuitive feeling that the concept of the reciprocal of space is utterly ridiculous; that we might equally well speak of the reciprocal of a cocker spaniel or the reciprocal of a load of hay. But I could not permit myself to accept this initial emotional judgment. I had to say to myself, "See here, this is just exactly what you have set out to do; to examine those thoughts that seem like nonsense, and to see if you can't find something of value in them."

So I began to take a critical look at the reciprocal concept, and as soon as I did so, it was immediately apparent that this idea was *not* so absurd, after all, since there definitely *is* a reciprocal relation between space and time in the *only* physical phenomenon in which we can recognize a direct association between the two: the phenomenon of *motion.* In motion more space is the equivalent of less time and vice versa. It makes no difference whether we travel twice as far in the same time or whether we travel the same distance in half the time. The effect on the speed, the scalar measure of the motion, is exactly the same in both cases.

Then, too, it was also evident that this reciprocal assumption was opening the doors to some new and logical answers for long-standing problems in physical science. One of these, a very important one, is the problem of gravitation. Here is one of the foundation stones of physical science. In the words of Paul R. Heyl, one of the leading investigators of the subject, "The more we study gravitation, the more there grows upon us the feeling that there is something peculiarly fundamental about this phenomenon to a

degree that is unequaled among other natural phenomena." Actually we do not know very much about it. Aside from some information of a mathematical nature, such as the inverse square relation, the relation of the force to the masses involved and the value of the gravitational constant, about all that we know from observation is that gravitation acts instantaneously, without an intervening medium, and in such a manner that its effects cannot be screened off or modified in any way. The point that impressed me most forcibly at the very beginning of my application of the reciprocal assumption to the gravitational problem was that this assumption led directly to a theoretical situation in which gravitation acts instantaneously, without an intervening medium, and in such a manner that its effects cannot be screened off or modified in any way.

Perhaps this may not strike some readers as anything particularly significant. Their reaction may be, "So what? Doesn't *any* theory have to agree with the observed facts in order to be considered valid?" And I would have to concede that as a general proposition this is true. But the significant point in this case is that *no* previous theory has agreed with the observed facts, and what is even more significant, present-day theorists are so convinced of the impossibility of *ever* formulating a theory that will agree with these facts that they have adopted the unprecedented policy of constructing a set of fictitious facts with which they *are* able to show agreement, and substituting these fictitious facts for the facts of observation.

Even though there is not the slightest evidence that gravitation is propagated at a finite velocity, present-day theorists have made this the cornerstone of their gravitational theories. It is not even *claimed* that this assumption is supported by any facts. Max Von Laue, for instance, makes this very frank admission, "Nowadays we are also convinced that gravitation progresses with the speed of light. This conviction, however, does not stem from a new experiment or a new observation; it is a result solely of the theory of relativity."[6] Then since such a propagation requires a medium, the theorists have had to assume the existence of a medium, even though here, again, there is not the least bit of evidence to support such an assumption.

It is commonly stated in the textbooks that Einstein's theories eliminated the need for a medium and consigned the "ether" of

the nineteenth century to oblivion. But this is a misrepresentation of the facts. Einstein's accomplishment in this area was merely a bit of scientific legerdemain. R. H. Dicke, one of our present-day gravitational experts, calls it a "semantic trick." Before Einstein, science had two concepts in this area, one which was called "space" and another that was called the "ether." What Einstein did was to eliminate the *concept* "space" and the *name* "ether," so that what current physical theory now has is the concept formerly known as the ether, but it is now called "space." Einstein himself cannot be charged with misrepresentation, as he freely admits that his space is actually an ether. "According to the general theory of relativity," he says, "space is endowed with physical qualities; in this sense, therefore, there exists an ether." Just how it is possible for an intangible entity such as space to have these physical qualities is a subject on which he is very vague. In his words, "Our only way out seems to be to take it for granted that space has the physical property of transmitting electromagnetic waves, and not to bother too much about the meaning of this statement."

The most striking result of the application of the reciprocal assumption to the gravitational phenomenon is that it produces a totally new explanation of a logical and rational character in an area where scientists have long been convinced that they have examined all possibilities and that no genuinely new explanation is possible. It is asserted over and over again in the scientific literature that there are only two options; either gravitation involves action at a distance, a concept that is generally rejected by scientists, or else it must be propagated at a finite velocity. We are told that any other alternative is logically impossible. But notwithstanding this dictum, another rational alternative does appear as soon as we start to examine the consequences of the reciprocal assumption.

This is no isolated case. Time and time again during the development of the new system of theory, completely new answers have been obtained in areas where present-day science claims to have examined "all conceivable alternatives." "There is no other way," Einstein tells us, in speaking of his assumption as to the contraction of space. But there is another way, and just as soon as this other way emerged from the investigation that I am now discussing, all contentions that

it did not exist were immediately and totally demolished. This is not a matter of opinion or judgment; just as soon as another alternative to *anything* is produced, all assertions that there is no such alternative fall by their own weight. It is clear from the many results of this kind that I have obtained that the human race has not yet reached the point where it is ever safe to assume that all possible alternatives have been examined. We may be wise, as we are claiming when we apply the name *Homo sapiens* to our species, but we are not yet omniscient. Regardless of any other merits that it may have, the investigation on which I have been engaged has made a very definite contribution to science by puncturing the claims of those who attribute finality to the current scientific opinions and theories.

This has a particular significance for those of you who are just beginning your life's work, because it means that, regardless of all contentions to the contrary, no doors are closed to you. You do not have to listen to those who say that their ill-contrived and unproductive ideas must be accepted because there is no other way. You do not have to be content with theories that are "conceptually imperfect," "riddled with inconsistencies," or full of "intolerable paradoxes," all of which are descriptions that have been applied to some of the most cherished products of modern science by prominent members of the scientific profession. You do not have to accept the statements of those who presumptuously assert that they have already examined all conceivable alternatives. Not only in science, but in all fields of human activity, you are at liberty to reach for the stars, and to reject the counsel of those who insist that you must be limited by the failures of your predecessors. There are some other limits, it is true. You cannot get something for nothing; you cannot have your cake and eat it too; and so on; but wherever there are genuine problems there are also answers, and those answers can be found if you will look for them without fixed presuppositions and prejudices.

At the stage of my investigation when I had completed my initial consideration of the most immediate consequences of the reciprocal assumption, some of these long-sought answers were beginning to appear over the horizon, and it was therefore clear that I had no option but to continue with my investigation, even though the task ahead was now vastly greater than anything that I had in mind

initially. This is a good example of what I was talking about earlier when I said that the investigation got out of hand, so to speak. At this point the sheer force of circumstances generated by the project itself simply forced me into a path that I previously had no intention of taking, and gave me a momentum toward a goal that had no place at all in my original plans.

The first problem with which I was confronted at the start of this new phase of my project was the necessity of making a decision as to the course of procedure to be followed. After considering various possibilities, I concluded that it would be advisable to see how far I could go in constructing a purely deductive system, starting with a minimum number of assumptions and developing the consequences of those assumptions step by step without introducing anything from outside the system. The construction of a theory of this kind comprehensive enough to cover the physical universe as a whole has always been the dream of science, and since the philosophy that I have been expounding here tells us that we should aim high, I decided that I should at least make the attempt.

Just what constitutes a minimum number of assumptions is not self-evident, but a review of those phenomena to which the reciprocal assumption appeared to be the most directly applicable, particularly electromagnetic radiation and the recession of the galaxies, indicated that the only physical assumptions, in addition to the reciprocal relation, that would be required to define these phenomena were that space and time are three-dimensional and that they exist only in discrete units. On the mathematical side, extrapolation of experience led to the assumptions that space and time conform to the relations of ordinary commutative mathematics, that their magnitudes are absolute, and that their geometry is Euclidean.

What I had in mind in starting the development with nothing but motion and its two aspects, space and time, and with only these six assumptions as to the properties of these entities, was that I would go as far as I could on this basis and then, when something else was needed in order to continue the development, I would introduce additional assumptions accordingly, keeping the number of these assumptions always at the bare minimum. It seemed rather obvious; for one thing, that I would not get very far before it would

be necessary to assume the existence of matter. But much to my surprise, when I examined the different kinds of motion that could exist on the basis of the original six assumptions, I found that one of these, simple rotational motion, would necessarily exist in the form of individual units, of such a nature that we can readily identify them as atoms; that these atoms would behave as if they were exerting mutual forces of attraction upon each other, a phenomenon that we can identify as gravitation; that the addition of successive units of motion to the different dimensions of the atomic rotation would take place in a definite sequence, resulting in the formation of a regular series of combinations that we can identify as the chemical elements; and so on. Thus both the existence and the characteristics of matter were consequences of the six assumptions already made, and it was not necessary to assume the existence of matter independently.

Since I now had both matter and motion to build with, the question naturally arose: Is anything else of a basic nature actually necessary? Twenty years of additional work answered this question in the negative. The only additional assumption that I found it necessary to make is the assumption that no more assumptions are required; that is, the assumption that space-time, or motion, whichever one prefers to call it, is the *sole* constituent of the physical universe. For convenience, I have combined this new assumption and the original six into two postulates, one as to the physical nature of space and time, and the other as to their mathematical behavior. The new physical theory that I am discussing is a purely theoretical structure derived from these two postulates, and *only* these two postulates, without introducing *anything* from observation or from any other outside source. The mere existence of space and time with the postulated properties has certain primary consequences. Interaction of these primary consequences with each other and with the postulates then results in a large number and variety of secondary consequences which, in turn, give rise to still further consequences, and so on until a whole theoretical universe has been defined.

The fact that this new theoretical system derives conclusions applicable to all sub-divisions of physical science from the same premises means that we now have, for the first time, something that can legitimately be called a theory of the physical universe. Few previous

theories are applicable to more than one of these subdivisions, and none is applicable to many of them. No previous theory, for instance, can produce a logical explanation of the recession of the galaxies, *and* of gravitation, *and* of the basic structure of matter, *and* of the nature of electromagnetic radiation. But all of these are merely the *immediate* and *direct* consequences of the basic postulates of the new system, just the beginning of the vast amount of information that can be derived by a more complete development of these consequences.

This comprehensive nature of the new theoretical system is the first of its distinctive characteristics that I want to emphasize. But the same thing that makes it a *complete* theory, the fact that it derives conclusions applicable to all sub-divisions of physical science from the same premises, also makes it possible to demonstrate that it is a *correct* theory, and that the theoretical universe derived from it is a true and accurate representation of the actual physical universe. The best way of explaining how such a proof of the validity of the system can be accomplished is to compare the construction of a theory to the preparation of a map.

Both maps and theories are often wrong, and they must be checked for accuracy before we can have full confidence in them. But the process by which the map or theory was produced has an important bearing on the nature of the tests that we apply and on the kind of conclusions that we are able to draw from the tests. In the case of a product of the traditional map making or theory construction processes, there is no option but to check each feature of the map or theory individually because, with relatively few exceptions, verification of any one feature does not guarantee the accuracy of any other feature. Verification of the position shown for a river in one part of the map does not assure us that the position shown for a mountain in some other part of the map is correct.

On the other hand, if a map or theory is prepared in one operation by a single process, as is true when the map is the result of aerial photography, and as is also true where all of the conclusions of a theory are derived from a single set of premises, the nature of the test is quite different. It is still necessary to compare some of the features of the map or theory with information that has been derived from other sources, but in this case the verification of the individual

features is merely incidental. The important point is that each such check is a test of the accuracy of the process. If even one feature of the map or theory is found to be in conflict with positively established facts derived from other sources, then the process is inaccurate and the map or theory as a whole is unreliable. But if no such discrepancy is found in the initial examination, then every additional check that is made without finding any discrepancy reduces the mathematical probability that any discrepancy exists anywhere in the map or theory. By making a sufficiently large number and variety of such checks, the probability of any error can be reduced to the point where it is negligible.

Of course, I have not yet examined the application of my new theoretical system to more than a relatively small portion of the total world of physical phenomena, for reasons which should be obvious. But, as I have just brought out, it is not necessary to check more than a representative sample of the features of an aerial photograph, or a theory of the analogous type, to be certain of its accuracy, and by this time I have examined the application of the theory to the fundamentals of all of the major branches of physical science, and I have made enough checks of the kind that I have been talking about to reduce the possibility of any basic error in the system practically to the vanishing point. Of course, the possibility that there may be some flaw in one or more of the long chains of reasoning by which conclusions regarding some of the finer details were reached cannot be excluded, but aside from this, I am now able to assert that the new theoretical system is an accurate representation of the physical universe.

The specific consequences of the postulates whereby the theoretical universe is defined are briefly outlined in Chapter 9 and developed in further detail in the three volumes of *The Structure of the Physical Universe.* Here, I will only give an illustration of the kind of new and logical answers to long-standing problems that emerge from this development. Since I have already discussed the gravitational problem at considerable length, this will be an appropriate example.

Inasmuch as the reciprocal of unity is unity, it follows from the reciprocal relation between space and time that one single unit of space is equivalent to one single unit of time. Consequently, when an additional unit of time has elapsed and some location A has progressed

to A+1 in time, it has also progressed to A+1 in space; that is, there is a continuous progression of space similar to the progression of time that we ordinarily visualize. This means that the space-time system is not a static system of the kind that we can represent by fixed coordinates; it is a moving system analogous to an expanding balloon. If there are spots painted on the surface of such a balloon, the distance between them is continually increasing, but this does not indicate any actual motion of the spots. They are fixed and they *cannot* move. The increase in separation is a property of the *system* in which the spots are located, not of the spots themselves. If there are any objects on the surface of the balloon that *do* move, the true measure of their motion is not the observed increase in separation, but the amount by which this observed increase is more or less than that which would exist if these object remained fixed to the surface in the same manner as the spots.

Whatever problem there may be in grasping the true situation here is simply a matter of getting accustomed to the idea of a moving system of reference. We ordinarily think of such things as location and motion in terms of a three-dimensional reference system that is stationary in space. But it is obvious that such a reference system is not applicable to an expanding balloon. A spot on this balloon that in fact *cannot* move and must remain permanently in the same location *does* move with respect to a fixed coordinate system. The use of such a reference system therefore gives us a completely distorted view of the situation. It attributes motion to objects that cannot and do not move, and it gives us a totally unrealistic picture of the motion of any objects that do move. In order to get the true picture of what is actually happening on the surface of the balloon we must utilize a moving reference system.

The same is true of the physical situation. We live in a space-time system which is continually expanding because of the equivalence of the unit of space and the unit of time. The distant galaxies are analogous to the spots on the balloon, and the motion that carries them outward away from us and away from each other is not actually a motion of the galaxies at all; it is a property of the system: the space-time system in which these galaxies are located. If any particular galaxy does have a motion of its own, the true measure of that motion is not the motion that we observe, but the amount by

which the observed motion differs from that which would exist by reason of the space-time progression alone. Here again, as in the case of the expanding balloon, we can get the true picture of what is happening only by the use of a moving reference system.

Now for a still closer analogy, let us replace the expanding balloon by an expanding transparent solid, and let us assume that there are visible objects in the interior of this solid analogous to the spots on the surface of the balloon. All that has been said about the expanding balloon is now equally applicable to the expanding solid. Then let us further assume that we take a moving picture of the expanding solid under lighting conditions such that we see only the objects in the interior and not the transparent solid itself. What this picture will show is a group of objects that are continually moving outward away from each other. Here we have a model of the galactic recession.

Next let us run this film backwards. What we will now see is a group of objects that are continually moving inward toward each other. If we had no knowledge of how this situation originated, we might very well conclude that these objects were exerting forces of attraction upon each other, and with a little ingenuity we could devise a mathematical expression that would enable us to calculate the magnitude of the force between any two of the objects, even though such forces do not actually exist. This analogy should provide a good understanding of the explanation of gravitation that is produced by the new system of theory, and it should also enable the reader to understand why previous gravitational theories have gone wrong. All previous theories have assumed that gravitation is a force, or at least some kind of an effect, that is exerted by one mass upon another, and the stumbling-block for these theories has been the fact that they could not account for the peculiar characteristics of the gravitational force, characteristics which are totally unlike those of any other force with which we come in contact. According to the new theory each atom of matter has an inherent motion in the inward space-time direction, and the peculiar characteristics of the gravitational force are all due to the fact that there actually is no force at all. As in our model, each unit is pursuing its own independent course, but that course takes it inward toward all other such units.

A question that is frequently asked is: "What happens to existing physical theory if your conclusions are correct; will a wholesale reconstruction of present theory be necessary?" The answer to this question is definitely, no. It is true that the new system does require some drastic changes in thinking in the far-out regions, the realms of the very small, the very large, and the very fast, but it should be realized that the present state of theory in these areas is little short of chaotic. Indeed, along the outer boundary lines present theory is essentially nothing more than speculation.

I recently purchased a book that purports to summarize all that is now known about the subject that it covers, one of the subdivisions of science in which I am particularly interested at the moment. The preface to this book contains the following very significant admission: "it will be seen from the discussion in the later chapters that there are so many conflicting ideas concerning theory and interpretation of the observations that at least 95 percent of them must indeed be wrong. But at present no one knows which 95 percent."[7] This is an extreme case, to be sure. There are not many scientific areas in which as much as 95 percent of current thought is incorrect. But there are a great many areas in which there is a very substantial percentage of error, a much greater percentage than is generally admitted. The existing situation, with particular reference to physics, is summed up in this statement taken from a recent issue of the magazine *Science News,* "The conditions are these: a large number of well-ordered facts, with no present way of explaining them, and a large body of frustrated scientists."[8]

My finding is that this frustration is a direct result of the fact that modern theorists have abandoned the traditional methods and goals of science. Up to about a century ago, the task of science was almost universally regarded as a matter of *discovery*. As expressed by R. B. Lindsay in a recent article in one of the journals, "Application of the term 'discovery' implies that there is an external world 'out there', wholly independent of the observer and with built-in regularities and laws waiting to be uncovered and revealed. They have always been there and presumably always will be; our task is by diligent search to find out what they are."[9] This was the viewpoint of Galileo, of Newton, and the other great pioneers of science.

The modern scientific establishment has repudiated this traditional viewpoint, and their present attitude is described by Lindsay in these words: "We are essentially viewing the purpose of physics as a scientific discipline as *invention* rather than discovery… The term invention implies that the physicist uses not only his observations but his imaginative powers to construct points of view that identify with experience."[9] Einstein was very emphatic on this score, and insisted over and over again that "we can only grasp physical reality by speculative means."[10] McVittie makes the same point in these words: "The Laws of Nature… are to be regarded as free creations of the human mind."[11] The inevitable result of giving free rein to the imagination in this manner has been that physical theory has lost touch with reality and has embarked on a course of pure speculation. Just in case someone might feel that this picture that I am describing is overdrawn, let me say that Werner Heisenberg, one of the principal architects of the modern speculative theory, is on record to exactly the same effect. He admits that modern science has "lost… the whole representation of reality which has been the basis of the exact natural sciences up to the era of today's atomic physics."[12]

When our primitive ancestors were confronted with something which they could not understand, their answer was to invent what we may call a demon, a supernatural being or power drawn from their imagination and specifically adapted to the purpose at hand. When the present-day theorist is similarly confronted with something which he cannot understand, *he* does exactly the same thing. He, too, invents a demon, a hypothetical force or phenomenon, which is designed specifically for this purpose, which has no other function, and whose existence cannot be verified by any independent evidence. There is no essential difference between the "rain god" that brings a much-needed shower for the benefit of the crops of the primitive tiller of the soil and the "nuclear force" that holds the hypothetical nucleus of the atom together for the benefit of the modern theorists. The explanations sound different, of course, because each cultural and professional group has its own jargon, but the essential character of the explanations would remain unchanged if the primitive farmer propitiated the "rain force" and the physicist invoked the aid of the "god of the nucleus." A demon is a demon, regardless of the particular linguistic clothes that he may happen to wear.

It is the wholesale use of these demons, and the consequent retreat from reality, that is responsible for the unsatisfactory state in which so-called "modern science" now finds itself, and it should be no occasion for surprise when a new theory that does not utilize demons calls for some drastic changes in the most demon-infested areas. But it should be remembered that, in spite of the great amount of publicity that they receive, these highly speculative modern developments actually constitute only a relatively small part of physical theory in general. Even the physics textbooks rarely devote more than ten percent of their contents to material of this nature, and the effect on other branches of science is very much less. The remainder of physical theory, perhaps as much as 95 percent of the total, has been constructed by the sound and reliable methods of traditional science rather than by "free inventions of the human mind," and my new theoretical system is generally in accord with this sound portion of existing theory.

As I have stated in my books, almost all of the theoretical relations applicable to our immediate environment that are firmly enough established to enable using them on a practical basis – such relations as Newton's laws of motion, the gas laws, the laws of thermodynamics, the kinetic theory, and so on – can be derived from the postulates of the new system in essentially the same form in which they are now known. Even the changes which the new theoretical system does make in these more familiar areas are often more a matter of altering the terminology than of any substantive modifications.

There are, however many gaps in existing theory, and these gaps are so prominent in this particular branch of science that chemistry is often characterized as primarily an empirical science. The leaders of the chemical profession have long been hoping to remedy this situation by developing an adequate chemical theory. At one time it was thought that the application of quantum mechanics to chemistry might be the answer, but the results of this effort have been disappointing. In fact, Professor Henry Bent of the University of Minnesota makes this flat statement in an article in the magazine *Science*; "This [30 years of] labor has produced not one firm prediction about even the simplest test-tube experiment."[13]

Chemists in particular are in a very favorable position to get the maximum amount of benefit out of the new development that I have

here described, a development that will ultimately give them that comprehensive chemical theory that has so long been lacking. It is on this basis that I commend it to their thoughtful consideration.

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CHAPTER 2

Just How Much Do We Really *Know?*

Physical science stands today in a highly anomalous position. On the one hand, no branch of knowledge has ever occupied a higher place in general public esteem. The spectacular way in which the abstract ideas of the theoretical scientist and the discoveries of his colleagues in the laboratories have been applied to the fashioning of ingenious devices that have drastically changed the whole world picture has made a profound impression on the man in the street, and the word "scientific" has acquired an unparalleled prestige. To some degree, at least, these sentiments are shared by the rank and file of the professional scientists, and the confident words"We know..." continually echo and reecho through the halls of learning.

But this unbounded confidence is completely lacking among the "insiders" of the profession, the relatively small group of theorists who bear the burden of keeping scientific theory equal to the growing demands upon it: demands which continually become more urgent as the pace of discovery quickens in the laboratories and in the observatories. These men make no secret of their dissatisfaction with present-day theory and their grave concern over the future of physical science. P.A.M. Dirac, for instance, tells us flatly that after many years of intensive research the efforts of the world's physicists to find a satisfactory theory have been a failure.[2] Coming as it does from one who has had a prominent part in the development of those modern theories which he characterizes as failures, this statement stands in marked contrast to the complacent attitude of the scientific profession in general with regard to the adequacy of the underpinnings of their theoretical structure.

Nor is Dirac alone in his opinion. Practically all of the most prominent leaders in theoretical science have expressed somewhat the same thought, explicitly or tacitly, at one time or another during

recent years. Erwin Schrödinger, another of the developers of current theory, fervently hoped for some "upheaval of old beliefs which in the end will lead to something better than the mess of formulas which now surrounds our subject."[3] P.W. Bridgman aimed many a sharp barb at the most cherished doctrines of modern science. "Is this honestly... a very impressive performance?" he asks, referring to wave mechanics. "Is it not exactly the sort of compromise that we should have predicted in advance would be the only possible one if it should prove that we were incapable of inventing any vitally new way of thinking about small-scale things?"[4] And he sums up his impressions of the General Theory of Relativity in these words: "...It seems to me that the arguments that have led up to the theory and the whole state of mind of most physicists with regard to it may some day become one of the puzzles of history."[5] Even Werner Heisenberg, whose attitude toward present-day theory is particularly sympathetic because of his close personal identification with some of the outstanding features of the system of thought currently in vogue, reveals his true appraisal of the existing situation when he admits, "It is obvious that at the present state of our knowledge it would be hopeless to try to find the correct theory of elementary particles."[6] Such comments and admissions by some of the principal architects of currently accepted theory are particularly significant, but there is no lack of confirmation from other sources. Some theorists are beginning to doubt whether an adequate theory can ever by constructed. C.N. Yang of Princeton, for example, was quoted in a recent news release as "expressing some doubts about the ability of the human brain in general, and his in particular, to accomplish this task."[7] Truly, as Philip M. Morse characterized the existing situation, "It is an unhappy time for theory."[8]

The question *Why?* naturally suggests itself. Why do the acknowledged leaders in the field take such a pessimistic view of the theoretical structure that is regarded so highly by the rank and file of the scientific profession: a structure that enjoys an acceptance so complete that even the most extravagant claims in its behalf are received without demur? The answer to this question is not at all difficult to find; on the contrary, it is almost immediately evident that these leading theorists are appraising currently popular theory

much less favorably *because they are applying more rigid standards in judging the validity of current claims to knowledge.* The scientist who attempts to clarify or improve the structure of theory cannot afford to follow the general practice of accepting today's best guess as the equivalent of fact; he has to do his best to make certain of the solidity of his foundation before he attempts to build anything upon it. All too often that foundation crumbles in spite of all of the care that is taken to check it thoroughly; anything less than this maximum care would simply invite disaster.

To those who look upon present-day scientific "knowledge" from this critical viewpoint it is obvious that much of it is not knowledge at all. Such a statement may seem incredible on first consideration, since it is generally understood that physical science is an "exact" science and that it draws a clear line of demarcation between factual and non-factual material. In theory this is true. Speculation and hypothesis play and important part in scientific research, but the products of such activity are not supposed to be considered in any way authoritative unless and until they are verified by experiment or observation. The most distinctive feature of science is that its acceptance of the established facts as the ultimate authority. As it happens, however, scientists are not only scientists, they are human beings, and in this latter capacity they are subject to the ordinary weaknesses of the human race, including a strong bias in favor of familiar and commonly accepted ideas, a totally unscientific reliance on presumably authoritative pronouncements, and a distinct reluctance to admit ignorance. All of these add up to a marked tendency to regard general acceptance as equivalent to proof, a tendency that has the effect of diluting the firmly established factual material of science with a larger admixture of matter of an unproved and uncertain character.

It is generally conceded that physical science is faced with a difficult and formidable task in readjusting its basic concepts to enable overcoming the obstacles that now stand in the way of further progress. Here are some of the recent comments on the subject: from J.R. Oppenheimer, "It is clear that we are in for one of the very difficult, probably very heroic, and at least thoroughly unpredictable revolutions in physical understanding to physical theory"[9]; from

Freeman J. Dyson, "For the last ten years it has been clear to most physicists that a basic conceptual innovation will be needed in order to come to grips with the properties of elementary particles"[10]; from David Bohm, "Moreover, physics is now faced with a crisis in which it is generally admitted that further changes will have to take place, which will probably be as revolutionary compared to relativity and the quantum theory as these theories are compared to classical physics"[11]; from Louis de Broglie, "...quantum physics has found itself for several years tacking problems which it has not been able to solve and seems to have arrived at a dead end."[12]; from Norwood R. Hanson, "The whole [quantum] theory may topple; in places the foundations seem far from secure"[13]; from Ernest Hutten, "Most physicists feel that the time is ripe, again, for a radical change in our ideas, and for a new theory."[14]

But what happens if the hopes of Schroedinger, Hutten, *et al.,* materialize and the revolutionary new theory which they anticipate so eagerly actually does appear? As matters now stand, such a theory will be summarily rejected, as it will inevitably conflict with many of the ideas and concepts that we are not permitted to question because they are part of the basic dogma of present-day science, even though they may owe that standing merely to general acceptance rather than to any factual support. The fate of these new ideas is all the more certain because the task of appraising them is normally left to a small group of individuals who, although they may be willing to concede the necessity for *radical changes* in principle, are strongly opposed to any change in the general lines of thought to which they are now committed. The average scientist does not normally feel that he can take the time to examine basic scientific concepts thoroughly. As Bridgman points out, many of the old ideas to which he subscribes "have not been thought through carefully but are held in the comfortable belief that some one must have examined them at some time."[15]

The objective of this memorandum is to bring out that under present conditions the scientific profession cannot afford to rely on this indefinite some one to put its theoretical house in order; the situation is too acute for that. These pages will emphasize the astounding degree to which general acceptance has been substituted

for proof in current scientific practice, and the almost incredible number of non-factual items which are masquerading as established facts. Obviously the new and better theory which is so greatly desired cannot be erected on any such dubious foundation, but if the debris is to be cleared away it will be necessary for the individual scientist to take a hand in the matter and arrive at his own conclusions, rather than to assume that some one will do it for him. It is not difficult for anyone to see how much of the scientific "knowledge" of the present day is merely pseudo-knowledge, once an effort is made to look the situation squarely in the face. Let us begin by pointing out that

Extrapolations from established facts do not constitute knowledge

A substantial part of what now passes for knowledge in scientific circles actually consists of extrapolations from observed facts rather than true factual material. As Bridgman once observed, many of these are "perfectly hair-raising extrapolations." A good example is the almost universal belief that we now know the nature of the processes which furnish the energy supply for the stars. Even in a day when "hair-raising" extrapolations are somewhat commonplace, this one sets some kind of a record. In view of the gigantic extrapolation that is required to pass from the relatively insignificant temperatures and pressures obtainable on earth to the immensely greater magnitudes which we believe (also through extrapolation) exist in the stellar interiors, even the thought that the answers *might* be correct calls for the exercise of no small degree of faith in the validity of our processes; any contention that the extrapolated results constitute actual knowledge is simply ridiculous.

To make matters worse, this is not merely an extrapolation. It also involves the assumption that the isotope of hydrogen which is stable under terrestrial conditions will become unstable under stellar conditions: an assumption that has no factual support. It is popularly believed that the hypothetical hydrogen-to-helium conversion process attributed to the stars is simply another "atomic bomb" type of reaction; we often hear the statement that in using atomic power we are drawing on energy from the same source utilized by the stars. The truth is, however, that all of our known atomic energy-producing processes depend on the existence of unstable isotopes that will

ultimately disintegrate of their own accord with the production of just as much energy if we let them follow their own course. All that we actually accomplish is to increase the *rate* of disintegration. The hypothetical conversion of the H? isotope to helium is not another process of this same kind; it is a process that does not take place spontaneously on earth or anywhere else that we know of.

Many atomic reactions which do not occur naturally, including this hydrogen-to-helium reaction, can be *forced* to take place under appropriate conditions. Small-scale experiments in the laboratories have indicated that some of these reactions are exothermic (or perhaps we should say exoergic, to be more general). From this the conclusion has been drawn that if the temperature is raised high enough, the kinetic energy of the atoms themselves will be sufficient to "ignite" a fusion reaction that will be self-sustaining. This sounds very plausible, to be sure, especially since we are accustomed to thinking of atomic reactions in terms of an analogy with combustion, but if we examine the conclusion carefully it is apparent that it involves the assumption that an exothermic process is a naturally occurring process, and we know that this is not always true. If it were, we would not need atomic power--we could beet our power requirements by desalting sea water. The currently popular theory of stellar energy generation is therefore not only a "hair-raising" extrapolation; it is also based on a very questionable assumption.

So far as the objective of this present memorandum is concerned, it is sufficient to show that the accepted ideas as to the nature of the stellar energy process are not necessarily true and that treating them as established facts is totally unjustified. It may be mentioned in passing, however, that there are actually several items of evidence which indicate that these ideas are not only open to question but are completely erroneous. For instance, it is a general rule in the laboratory experiments involving high energy impacts that the degree of fragmentation becomes greater as the incident energy increases. If this rule holds good at stellar temperatures and pressures, and we have no reason to think otherwise, it favors the existence of hydrogen atoms rather than helium atoms. Even the combustion analogy suggests this same conclusion. Extremely high temperatures do not favor exothermic chemical combinations; on

the contrary, they dissociate the combinations that already exist. Furthermore, the hypothesis of a self-sustaining hydrogen reaction ignited by high temperature in a body consisting primarily of hydrogen introduces a problem of control for which there seems to be no answer. The steady and relatively slow generation of energy which we actually observe in most stars requires some kind of a definite limitation on the energy supply or on the process itself which is wholly incompatible with current concepts. Other lines of reasoning based on such evidence as the ratio of hydrogen to helium in the cosmic rays and many observed facts from the astronomical field lead to similar conclusions.

Conclusions based on extrapolations are not knowledge.

If a physical theory that has been generally accepted on the strength of faulty or inadequate evidence is actually valid in spite of these deficiencies, as we can expect will frequently be true, no harm has been done. On the other hand, if such a theory is not valid, the bad effects are not necessarily confined to the area directly affected; they may be multiplied manifold by the use of the original erroneous conclusion as a base for the erection of additional theories. A mistaken idea as to the source of the energy of the stars is not too serious in itself but, as it happens, the whole structure of stellar evolutionary theory has been based on this assumption as to the nature of the stellar energy generation process, and the net result has been a serious distortion of the entire astronomical picture.

The astronomer does his work under rather severe handicaps. He cannot experiment; all that he can do is to observe. Furthermore, the range of conditions within his field of observation is so much greater than the range existing on earth that much of what he observes can be related to familiar phenomena only by long extrapolations, and these, as has been brought out, are always subject to serious question as to their validity. Then also, the astronomer is, for the most part, limited to what is essentially an instantaneous picture, even though it encompasses a wide expanse of time as well as space. He sees astronomical objects in what are apparently various stages of evolution, but he cannot determine the direction of evolution from direct observation; he must draw his conclusions on this point from collateral evidence of some

kind. In addition to these inherent and unavoidable handicaps of his profession the astronomer has voluntarily accepted another: a blind and unquestioning faith in the conclusions of the physicists with respect to the stellar energy process.

Some quite definite evolutionary direction signs are available in the astronomical field itself, but rather than take issue with the physicists, the astronomers have chosen to ignore these signs and to base their ideas as to direction solely on the hypothetical energy generation process. If this process is actually operative then it necessarily follows that the hot, massive stars, which are radiating enormous amounts of energy, must be comparatively young, as their supply of hydrogen could not maintain this tremendous energy output for more than a relatively short time. But this raises some very difficult questions. As Bart J. Bok states, "It is no small matter to accept as proven the conclusion that some of our most conspicuous supergiants, like Rigel, were formed so very recently on the cosmic scale of time measurement"[16] and Cecilia Payne-Gaposchkin tells us that the results of age calculations based on this hydrogen conversion process are "staggering."[17] However, the astronomers have, almost without exception, shrugged off the contradictory evidence from their own observations and have accepted this product of a "hair-raising" extrapolation by the physicists as an incontestable fact. Explanations of stellar evolution almost invariably begin with some such statement as this which introduces Payne-Gaposchkin's discussion of the subject: "The problem of the ages of stars in closely interwoven with the problem of stellar nutrition... A star can shine only so long as hydrogen is available."[18]; or this from Struve: "...Our new insight into the age of the stars stems from our new knowledge of how these bodies produce their energy."[19]

Here is eloquent testimony to the serious consequences of the lack of adequate discrimination between factual and non-factual material in present-day scientific practice. The atomic physicists themselves are not deceived. They know that the concept of a self-sustaining process of conversion of the stable hydrogen isotope to helium is only a hypothesis, not a fact, and if we read the fine print, we will find them admitting that this is the case. For example, R.E. Marshak in an article entitled "The Energy of the Stars" makes this

statement: "So we can safely assume that the stars produce energy by the combinations of light elements through the collisions of their swiftly-moving nuclei"[20] and Louis Ridenour sums up Marshak's entire article in these words: "...As Robert E. Marshak explained in the previous article, there is excellent reason to believe that the energy source of most stars...is rather a complicated chain of nuclear transformations whose end result is to form one atom of helium out of four atoms of hydrogen."[21]

But unfortunately this concept of the energy generation process is not usually presented in its true light as something "we can safely assume" or something "there is excellent reason to believe." Because of the overwhelming confidence of the physicists in the validity of their hypothesis, a confidence based more on the prestige of the profession than on the merits of the hypothesis itself, there is a general tendency to talk in terms of positive knowledge, and by the time this hypothesis reaches the astronomers it has become an article of faith against which factual evidence is powerless. E. J. Öpik tells us: "This knowledge [of the conversion of hydrogen to helium] is so well founded that it furnishes a reliable basis for the calculation of time rates of stellar evolution."[22] The high estate to which the "assumption" and "belief" of the physicist has now risen is all the more remarkable since Öpik admits on the very next page that this reliable basis is clearly unreliable. "The energy source of the giants remains a puzzle," he says, and hence "some uneasiness may be felt" about the application of the theory to the white dwarfs. Otto Struve's confidence in the energy generation process, as reflected in the statement previously quoted, is equally remarkable in that it is apparently undisturbed by the fact that this "new insight" of which he speaks forces him to characterize factual knowledge from his own field as "apparent defiance of the modern theory of stellar evolution."[23]

The damaging effect of these unjustified claims to positive knowledge in basic physics is by no means confined to relatively distant fields such as astronomy. Even physics itself is highly compartmental in present-day practice, and the individual physicists are reluctant to cross boundary lines. Leprince-Ringuet describes the situation in these words: "A physicist bears the stamp imposed by the rigid and precise demands of his discipline. At meetings he

rarely comments on anything that lies outside of his own well-defined specialty."[24] If the findings of each minuscule division of science are to be accepted without question by the rest of the scientific profession, this merely underlies the necessity of more accurate definition of the true nature of the conclusions that are research, and some measures that will discourage the tendency to say "We know..." when the expression should be "We think..." Perhaps we have reached the point where we need some interdisciplinary agency to restrain the enthusiasm with which the various specialists overstate the case for the current popular theories in their respective fields.

Extrapolations of negative results are not knowledge

In addition to the type of extrapolation which has been discussed, there are also what we may call extrapolations of the negative. Here we find through observation that certain things do not happen in regions directly accessible (the earth, primarily). We then generalize this observation by extrapolating it to the regions that are not accessible, and we say that such things never happen. There is nothing inherently wrong about such an extrapolation, or any other type of extrapolation; on the contrary, reasoning from the known to the unknown is sound practice. But it must not be forgotten that an extrapolation of an observed fact is something totally different from the fact itself, and conclusions reached by extrapolation cannot be more than tentative until they are confirmed in some way.

A good example of this type of extrapolation is proved by the question of isotopic stability. Under terrestrial conditions the isotope Fe^{56} is stable. In the absence of any evidence to the contrary, we assume that stability is an inherent property and that Fe^{56} is always stable. Similarly we assume that the neutron is always (with one curious exception) unstable because it is unstable in the region where we can observe it. These are natural and logical assumptions under the circumstances, but they are *only* assumptions, not established facts. Consequently they cannot be used to refute any theory which contends that isotopic stability is determined by the environment and that under appropriate conditions the neutron may be stable and Fe^{56} unstable. If such a theory is to be attacked, it must be challenged on other grounds. There mere fact that it conflicts with an extrapolation

of terrestrial experience is irrelevant, since that extrapolation has no factual standing, regardless of the unanimity with which it is currently accepted.

Conclusions based on extrapolation of the negative are not knowledge

Here again we find the extrapolations serving as the basis for additional conclusions and again it should be emphasized that such conclusions are not facts and they cannot be used in lieu of positive knowledge. Mush of the current thinking about the cosmic rays, for instance, follows along lines dictated by the belief that those particles which are short-lived in the terrestrial environment are likewise short-lived in interstellar and intergalactic space. The available factual information neither confirms nor denies this assumption. Certainly the burden of proof rests upon anyone who suggests that isotopic stabilities in free space differ from those which we find in the terrestrial environment, but if any evidence can be produced in support of such a suggestion there is nothing in the currently available data from experiment or observation that can refute such evidence. The mere fact that practically everyone *believes* that the stability or lack of stability is inherent does not make this true. Scientific questions cannot be settled by public opinion polls. However numerous its supporters may be, this is still nothing more than a conclusion based on an unsupported extrapolation of the observed facts, and as such it cannot qualify as knowledge. In this connection it is interesting to note that current ideas regarding stability are not consistent. The same physicist who reacts violently to the suggestion that stability may be a function of the environment and that his conclusions as to the atom-building and similar processes in the extra-terrestrial environments may therefore be wide of the mark, does not hesitate to advance exactly the same hypothesis when he finds this necessary in order to fit the theory that the normally unstable neutron is a constituent of stable atoms.

Conclusions outside the scope of the observations are not knowledge

Somewhat analogous to the practice of extrapolation, but of a more questionable characters, is the practice of exaggeration; that is, claiming more than what the observations or measurements actually substantiate. A classic example is Einstein's theory that mass is a

function of velocity. Throughout scientific literature this theory is described as having been "proved" by the results of experiment and by the successful use of the predictions of the theory in the design of the particle accelerators. Yet at the same time that a host of scientific authorities are proclaiming this theory as firmly established and incontestable experimental fact, practically every elementary physics textbook admits that it is actually nothing more than an arbitrary selection from among several possible alternative explanations of the observed facts. The experiments simply show that if a particle is subjected to an unchanged electric or magnetic force, the resulting acceleration decreases at high velocities and approaches a limit of zero at the velocity of light. The further conclusion that the decrease in acceleration is due to an increase in mass is a pure assumption that has no factual foundation whatever.

As one textbook author explains the situation: "There seems to be no reason to believe that there is any change in the charge, and we therefore conclude that the mass increases." Another says: "This decrease is interpreted as in increase of mass with speed, charge being constant." Obviously an interpretation of the observed facts is not a fact in itself, and it is rather strange that the theorists have been so eager to accept this particular interpretation that they have not even taken the time to examine the full range of possible alternative interpretations. As these quotations from the textbooks indicate, it has been taken for granted that either the charge or the mass must be variable, but actually it is the acceleration that has been measured, and the acceleration is a relation of force to mass, not of charge to mass. The accepted interpretations of the observed facts therefore contain the additional assumption that the effective force exerted by a charge is constant irrespective of the velocity of the object to which it is applied. The possibility that this assumption is invalid cannot logically be excluded from consideration; on the contrary, there are some distinct advantages in maintaining both charge and mass as constant magnitudes. When we get down to bedrock it is clear that the theory of an increase in mass is not something that has been proved by experiment, as is so widely claimed; it is a pure assumption that goes beyond the scope of the experiment, and is only one of several possible alternatives. Any theory which leads to the observed decrease

in acceleration at high velocities is equally as consistent with the observed facts as Einstein's theory that the mass increases.

A principle of impotence is not knowledge

One of the disturbing features of current scientific practice is the increasing tendency to rationalize failure to solve difficult problems by setting up postulates that solutions to these problems are impossible. As Alfred Lande puts it: "In short, if you cannot clarify a problematic situation, declare it to be 'fundamental,' then proclaim a corresponding 'principle.'"[25] Herbert Dingle quotes a physicist who even goes so far as to contend that we are at last firmly grounded on the principle of uncertainty.[26] And these are no minor matters out of the periphery of physical theory; they are matters of vital importance to the foundations of the theoretical structure. Quoting R. B. Braithwaite: "Such propositions [principles of impotence] play a very large part at the present time in the fundamental theories of physics."[27]

It should hardly be necessary to point out that from their very nature these principles of impotence are incapable of proof and are never entitled to the status of established facts. It is very doubtful whether they should even be recognized as legitimate scientific devices, to say nothing of being given any authoritative standing. Some of them should certainly be barred. The underlying concept upon which all scientific research is based, and without which the application of time and effort to this task would be wholly unjustified, is the conviction that the physical universe is essentially reasonable and operates according to fixed principles. Thus far we have never encountered any actual evidence to the contrary; as scientific knowledge has expanded one after another of the phenomena that were inexplicable to our early ancestors has been found to follow fixed and unchanging laws. But now there is a growing use of a practice which is not only questionable by nature, in that it is an easy way of avoiding the difficult task of solving complex problems, but also leads to conclusions which are in direct opposition to the philosophical premise which is our only justification for undertaking scientific research in the first place.

Conclusions such as this from Heisenberg: "...The idea of an objective real world whose smallest parts exist objectively in the

same sense as stones or trees exist, independently of whether or not we observe them...is impossible[28] or this from Bridgman: ...The world is not intrinsically reasonable or understandable; it acquires these properties in ever-increasing degree as we ascend from the realm of the very little to the realm of everyday things,"[29] or this from Herbert Dingle: "The 'real' world is not only unknown and unknowable but inconceivable – that is to say, contradictory or absurd,"[30] are completely at odds with the underlying philosophy of scientific research. If we had some definite and positive evidence that they were true, we should have to accept them, however unpalatable they may be, but accepting them purely on the strength of principles of impotence, which means that they have no factual support at all, is totally illogical.

The bald truth is that these statements are simply efforts to avoid admitting failure. The theorists have failed in their attempt to discover the exact physical and mathematical properties of the component parts of the atom, and rather than admit that their abilities are unequal to the task, as C.N. Yang suggested in the interview previously mentioned, they prefer to postulate that these properties do not exist and that even the atom itself, as Heisenberg says, "has no immediate and direct properties at all."[31] The ironic part of it is that it is now beginning to become evident that the task at which the theorists have failed is not an impossible task, as they would like to have us believe, it is a meaningless task. As will be brought out later in this memorandum, a growing mass of evidence indicates that the atomic constituents whose properties have been so difficult to define simply do not exist at all: a possibility that should have been given serious consideration long ago. When the most strenuous efforts over a long period of years by the best minds in the scientific profession fail to clarify the properties of the hypothetical constituents of the atom, and finally lead to the conclusions that these entities have no definite properties and do not even "exist objectively," mere common sense certainly calls for a thorough examination of the obvious possibility that they do not exist at all. But this natural and logical explanation of the difficulties that have been experienced has been completely ignored while the theorists have gone on an uncontrolled excursion into a weird land of fantasy completely divorced from physical reality.

In this instance the great prestige of physical science, and physics in particular, has operated to its detriment by permitting it to transcend the limits of logic and common sense unchecked by those restraints which are applied to all less glorified branches of knowledge. As James R. Newman very aptly remarks: "In this century the professional philosophers have let the physicists get away with murder. It is a safe bet that no other group of scientists could have passed off and gained acceptance for such an extraordinary principle as complementarity, nor succeeded in elevating indeterminacy to a universal law."[32]

Since a principle of impotence is inherently incapable of proof, it is obvious that claims of proof of such propositions are fallacious. Ordinarily the fallacy is not difficult to locate. For example, the First Postulate of Relativity, the denial of the existence of absolute motion, is a principle of impotence. It is commonly presented in the guise of positive knowledge, not because it is contended that this postulate itself have been proved, but because the Relativity Theory is claimed to have been proved, and this is a part of that theory. The fallacy lies in the fact that the Relativity Theory has not been, and cannot be, proved as a whole, since it includes four independent postulates. Two of these, the constant velocity of light and the equivalence of gravitational and inertial mass, are supported by sufficient factual evidence to justify the contention that they have been proved. Actually these are not theories at all; they are experimental facts which most physicists were willing to concede even before they were incorporated into the Relativity Theory. But there is no logical justification for extending the evidence in favor of these two postulates to the First Postulate, which has no *necessary* connection with the other two, beyond the fact that it was wrapped up in the same package by the originator of that theory.

The First Postulate is simply one of the possible ways of getting around the contradiction introduced by the experimental discovery of the constant velocity of light, and it has won general acceptance by default, because no one has seen fit to develop a case in favor of any of the various alternatives. Within the framework of accepted theories of space, time, and motion, the constant velocity of light is definitely incompatible with the concept of absolute velocity, and Einstein chose to sacrifice absolute velocity. It is equally feasible to retain

absolute velocity and to modify present space-time concepts instead, particularly since there are no great demands on this postulate; the only purpose that is serves is to evade the contradiction that would otherwise exist. It is rather surprising that this possibility has not been explored, considering the tremendous amount of time and effort that has been devoted to research in theoretical physics. There is no obvious advantage in such a substitution of postulates, since it would not change any of he essential aspects of Relativity, but the mere fact that there is no definite purpose in plain sight does not ordinarily deter basic research. Exploration of the various alternatives would at least clarify the status of the so-called "paradoxes," as these are consequences of the First Postulate and replacement of this postulate by one of the alternatives would either eliminate the paradoxes or substitute a new set for the ones now existing.

Theories that conflict with known facts are not knowledge

The truth of this statement is self-evident and it may seem superfluous to mention it, yet some of the most important items of present-day physical "knowledge" fail to qualify as such under this rule. For example we know that positively charged particles repel each other with a force which becomes very great at short distances. On the basis of what we know, therefore, it is impossible for a number of protons to remain together in a unit such as the atomic nucleus. Likewise we know that the neutron is unstable in the local environment, and on the basis of what we know the existence of neutrons in a stable atom is impossible. This does not mean that the nuclear theory is necessarily wrong; there may be factors in the situation of which we are ignorant. But it does mean that the nuclear atom is not something that we know; it is a hypothesis, and one of a very dubious character. Yet the pressure for conformity to accepted ideas is so strong that the existence of the hypothesis is considered proof of the existence of some unknown force: a "nuclear" force opposing the known force that would otherwise disrupt the hypothetical structure. The logical justification for this line of thought is certainly hard to detect.

It may be assumed, however, that these conclusions have been influenced to a considerable degree by the impression that the

existence of an atomic nucleus was proved by the early experiments of Rutherford, who showed that fast-moving particles pass through thin sheets of solid matter without interference except in cases where they make direct hits on what is now identified as the nucleus. As a result of these and similar experiments it has been concluded that almost all of the mass of the atom is concentrated in this relatively small region. But here again we encounter the same curious failure to explore alternatives that has been noted earlier in this discussion. The experimental results are consistent with the conclusion that almost all of the mass is concentrated in a relatively small volume, to be sure, but they are equally consistent with the alternative conclusion that *all* of the mass is concentrated at this point; in other words, that this is the atom, not the nucleus of the atom. It seems to have been completely overlooked that while there is ample evidence of the existence of something massive at the center of the region in which the atom is located, there is nothing at all to confirm the existence of the hypothetical outer parts. The idea that the atoms are in contact in the solid state is pure guesswork; indeed the fact that the inter-atomic distance can be reduced very substantially by application of pressure, to less than half in some cases, strongly suggests that the spacing in the solid is imply the result of a force equilibrium. The conventional diagram of the NaCl crystal found in most elementary chemistry textbooks may be a fairly accurate representation of the physical facts.

The other mainstay of the present-day theory of the atom is the fact that electrons can be obtained from atoms, particularly as products of atomic disintegrations. This is the overriding point that has convinced the scientific world that electrons are constituents of atoms, and has made it easy for any additional finding which is *consistent* with the nuclear hypothesis to be accepted as *proof* of its validity. The ,argument may be summarized as follows:

1. Under certain conditions atoms disintegrate.
2. Electrons are found among the disintegration products.
3. Therefore, electrons are constituents of atoms.

At first glance this argument may seem sound, and certainly it has been accepted without serious question, but its true status can be

brought out clearly by stating the analogous argument concerning the photon:

1. Under certain conditions atoms disintegrate.
2. Photons are found among the disintegration products.
3. Nevertheless, photons are not constituents of atoms.

Here we find that on the basis of exactly the same evidence, current practice arrives at diametrically opposite conclusions. Because preconceived ideas concerning the electron suggest that it could be an atomic constituent, the evidence from the disintegrations is accepted as proof that it is, whereas similar preconceived ideas concerning the photon suggest that it could not be an atomic constituent, and exactly the same evidence is therefore taken to mean that the photon was created in the process. Actually, of course, the physical evidence does not distinguish between these alternatives, nor does it preclude the possibility that some other explanation may be correct. What the evidence shows is that the electron either

1. was a constituent of the atom, or
2. was preexisting within, but not a part of, the atom, or
3. was derived from the surrounding space, or
4. was created in the disintegration process, or
5. originated from some combination of the foregoing, or
6. had some other origin consistent with the evidence.

The clear and positive picture of the atom set forth in the physics textbooks has long since been abandoned by the "front-line" theorists, as by this time it is evident that the concept of such a structure is untenable. What started out in the original nuclear atom conceived by Rutherford and developed theoretically by Bohr as the identifiable and physically observable entity which we know as the electron has now become a mysterious something which no one seems to be quite able to define. Heisenberg tries. "The indivisible elementary particle of modern physics, he tells us, is not a material particle in space and time but, in a way, only a symbol on whose introduction the laws of nature assume an especially simple form."[33]

It is nothing short of ludicrous to find our elementary textbooks explaining the present-day "knowledge" of the structure of the

atom in positive terms and in great detail, while at the same time Heisenberg and the Copenhagen school, who represent the "official" viewpoint of present-day theoretical physics, tell us that "the atom of modern physics can only be symbolized by a partial differential equation in an abstract multidimensional space."[34] The statements commonly found in the textbooks, such as this one: "There is so much physical and chemical evidence for the correctness of the modern atomic picture that there can be no reasonable doubt of its validity,"[35] become nothing but absurdities when the "modern atomic picture" explained in detail by the textbook authors is flatly repudiated by the leading theorists in the physical field.

The truth is that the "physical and chemical evidence" which is given so much weight by these authors is not actual evidence of the nuclear atom; it is evidence which is consistent with that hypothesis, but which is equally consistent with other hypotheses, and therefore is not a proof of any of them. Many physical and chemical phenomena, for example, are functions of the number of "valence electrons" which the atom presumably possesses, according to the nuclear theory, and these relations constitute a major part of the "evidence" to which the textbook authors refer. But if these relationships are examined critically it will be found that the electron, as such, plays on part in them. The are relations which involve only numbers, and whether these are numbers of electrons or numbers of something else in completely immaterial. We find, for instance, that Moseley's Law relates the x-ray frequencies of potassium to the number 19, and this is taken as a confirmation of the hypothesis that the atom of potassium contains 19 electrons. But there is not the slightest evidence that electrons have anything to do with this situation. The relation is solely with the number 19 and any theory which leads to the existence of 19 units of any kind in the potassium atom is perfectly consistent with the experimental knowledge.

Much the same kind of statement can be made about almost any experimental result that is now expressed in terms of the nuclear theory. The experimenters who are busily engaged in measuring "nuclear cross-sections," for example, will probably be horrified at the suggestion that there is no such thing as a nucleus. But these investigators are measuring cross-sections, not nuclear cross-

sections. The identification with the nucleus is theoretical, not experimental, and if the theory has to be changed this does not affect the experimental results--it simply changes the language in which they are expressed. We just substitute "atomic" for "nuclear" and everything else goes on just the same. The prevailing impression that the huge mass of experimental information of this kind accumulated in recent years constitutes evidence of the validity of the nuclear theory is entirely erroneous.

Summarizing the foregoing discussion, it is not necessary to assume the existence of an atomic nucleus to explain the results of Rutherford's experiments and Occam's Principle, one of the sound common-sense rules of science, tells us that we should not make unnecessary assumptions. Furthermore, the fact that electrons can be obtained from matter, as a result of disintegrations or other processes, is not a proof that the electron is a constituent of matter, nor does it even prove that the electron existed prior to the event that caused it to appear. This demolishes the two primary arguments in favor of the nuclear theory, the arguments which have been relied upon to offset the two definite and positive conflicts between this theory and known facts. At this point, therefore, it would appear that the nuclear theory is not only unproved, but is actually disproved. The question then arises, must the entire electrical theory of matter be discarded? But when we remember that the electrical theory antedated the nuclear atom by about one hundred years it is evident that this theory is not tied to the nuclear hypothesis; it simply goes back to where it was before Rutherford. However, this does not necessarily mean that it stands on solid ground, so let us take a look at the facts.

The electrical theory of matter originated from the observation that certain substances on being dissolved separate into two parts, or ions, one bearing a positive charge, the other a negative. Later, various phenomena such as the thermionic emission of electrons, the photoelectric effect, etc., which involve ejection of electrons from matter, where discovered. Since the experimentally observed electron is a negatively charged and highly mobile particle, it was concluded that the ionic charges were due to an excess or deficiency of electrons relative to the number which the atoms presumably should contain in the neutral condition. This is plausible, and in

many respects a rather attractive theory, but for present purposes these aspects are irrelevant. What we ant to know is, does this theory constitute positive knowledge, as the textbooks contend? The answer to this question is definitely no; close scrutiny shows that here again we have nothing more than a very questionable hypothesis.

Looking first at the matter of ionization in solution, it is clear that this is the same kind of a situation that exists in the case of the electrons which appear among the atomic disintegration products. The theory that the electric charges existed prior to the time that the substance dissolved is only one of the possible explanations of the observed facts. It is not even the best of the readily available explanations, because if we accept it, we find it necessary to conclude that there are two different ionization mechanisms. The general chemistry textbook on the author's desk admits that ions are formed no only by the so-called "ionic" compounds but also by compounds that are definitely not ionic, and goes on to say: "If ions are not presently in an electrolyte before it is dissolved, they must be formed from the molecules of the compound as it dissolves."[36] But as long as we have to assume that some ionic charges are created in the process of ionization, it is clearly within the bounds of possibility that all ionic charges are thus created: an explanation that has a considerable advantage from the standpoint of simplicity. The existence of charged particles in solution is therefore far from being proof of the existence of electric charges in undissolved matter. Similarly, everything that is known about the photoelectric effect, the thermionic emission of electrons, and other phenomena of this kind is entirely consistent with the hypothesis that the charged particles are created in the process. Obviously we cannot regard any theory as having been verified by experiment if the experimental results are equally consistent with some different hypothesis, and hence none of these results qualifies as a proof of the electrical theory of matter.

At the time the nuclear atom was originally conceived, the idea that electrons might be created in some physical process seemed so remote that it was probably never even given consideration, but today it is commonplace. Such creation is currently being observed in a great variety of processes, ranging all the way from the production of a single electron-positron pair by an energetic photon to the production

of a shower of millions of particles by a cosmic ray primary. We now find that the electron with which we deal experimentally is something altogether different from the atomic building block envisioned by Rutherford; it is a tangible but evanescent particle that can be produced or destroyed with relative ease.

If we take a broad view of the entire picture of the electron, including both theory and experiment, it is apparent that there is a curious dichotomy in the usual concepts of this particle. The experimental electron is a definite and well-defined thing, notwithstanding its impermanence. We can produce it at will by specific processes. We can measure its mass, its charge, and its velocity. We can control its movement and we have processes by which we can record that path that it takes in response to these controls. Indeed, we even have such precise control over the electron movement that we can utilize it as a powerful means of producing magnified images of objects that are too small for optical magnification. In short, the experimental electron is a well-behaved and perfectly normal physical entity. On the other hand, the theoretical electron, which, according to currently accepted theory, is one of the constituents of the atom, is a very strange phenomenon. It presumably moves in an orbit around the atomic nucleus, but we cannot locate either the orbit or the position of the electron in the orbit; the best we can do, the experts say, is to compute a probability that it might be found at a certain location. Unlike the experimental electron, this theoretical electron does not follow ordinary physical laws, but has some unique and unprecedented behavior characteristics of its own, including a strange and totally unexplained ability to jump from one orbit to another with no apparent cause. Furthermore, as already mentioned, the leading theorists of the present day tell us that it cannot be accommodated within the three-dimensional framework of physical space; it must be regarded merely as a symbol rather than as an objectively real particle.

Under the circumstances it becomes pertinent to inquire whether there is actually any adequate justification for identifying the theoretical electron of the nuclear atom with the experimental electron. Once this question is asked, it clearly must be answered in the negative. Certainly we cannot logically contend that two entities that differ widely in practically every respect are actually identical.

What has happened is that the theorists originally started out with the assumption that one of the constituents of the atom is a particle identical with the experimental electron, but as more and more information was accumulated it became clear that the properties of the experimental electron were incompatible with the requirements of the hypothetical atomic constituent. The assumed properties of the atomic electron have therefore been progressively modified to meet these requirements until they now bear no resemblance to those of the experimental electron. It is high time, therefore, that the pretense of identity should be abandoned and that the "electron" constituent of the nuclear atom should be recognized for what it actually is: a purely hypothetical concept which has no relation nor resemblance to any particle that has been observed experimentally.

Naturally the physicist is reluctant to take this step, in spite of the absurdity of claiming identity for two particles which have practically nothing in common, since the modern theory of the atom rests on the assumption that it is a composite structure built up by a combination of some of the smaller particles which have been observed experimentally. Once it becomes necessary to admit that the atomic electron is a purely hypothetical creation, unrelated to anything that has ever been observed, "an abstract thing, no longer intuitable in terms of the familiar aspects of everyday experience," as H. Margenau describes it,[37] this basic concept of the atomic structure is destroyed and the whole theory crumbles. After having been so confident for so long, the physicists find it very distasteful to face the realities of this situation and to admit that the concept of an atom constructed from known particles of sub-atomic size is no longer tenable. But this is exactly the kind of catharsis that we need in order to clear the way for a new physical theory adequate to meet present-day demands. After all, how can we expect a theory based on the assumption that matter is composed of permanent "indivisible elementary particles," similar in all respects, other than size, to the atoms of Democritus, to give us the right answers in an age when it is admitted that "we do not really know how to define an elementary particle,"[38] but we do know that no particle is permanent; that all particles, large or small, material and non-material, are subject to exchange of identities in a bewildering variety of transformation reactions?

Actually we must go still a step further. Not only is it now clear that the constituent parts of the atom are not known particles such as electrons, it is also becoming apparent, as mentioned earlier in the discussion, that the atom has no constituent parts at all. Of course, the immediate reaction to this statement will be that it is preposterous, since we can readily break the atom into separate parts. But let us examine this situation a little more closely. Suppose we have a certain object moving with a high velocity, and we then detach the velocity by transferring it to something else. Must we then conclude that the original object consisted of two separate parts and that we have broken it into its two constituents? It is very doubtful whether anyone would ever support such a conclusions as this, but if we compare this situation with the break-up of the atom, it is evident that the only basis on which we can claim that we have done something different with the atom is by contending that the parts which are detached from the atom are inherently of a different character than the motion which was detached from our hypothetical object.

Can such a contention be justified? We have found that both the proton and the electron can be transformed into radiation simply by contact with their respective antiparticles. "All matter seems to be radiation," says Morse[39] and so far as we know, radiation is nothing more than a vibratory motion. Can we say that the proton is inherently different from motion when we can transform it into motion? Are we not forced to the conclusion that the atom could very well be an integral entity endowed with specific amounts of various kinds of motion (or something equivalent to motion) and that what we call breaking it up into parts amounts to nothing more than detaching portions of this motion (or the equivalent thereof)?

And is it not true that the trend of discovery in the sub-atomic field is driving us slowly but inexorably in this direction, toward just such a conclusion as the foregoing? Already it is evident that there must be some common denominator, not only for the particles, but for radiation as well. Particles are materialized from radiation and are "annihilated" back to radiation again, protons become neutrons and vice versa, mesons are created from kinetic energy and ultimately decay into electrons and neutrinos. The atomic reactors transform mass into energy, while at the same time the particle accelerators

are busily engaged in converting energy back into mass. This interchangeability between the "elementary" particles, between the particles and radiation, and between mass and energy, has already administered the *coup de grace* to the popular theory that the universe is constructed from different kinds of elementary "building blocks" even though the inertia of customary habits of thought and a strong attachment to familiar ideas are delaying general recognition of this fact. It is already evident that the raw material of atom building is more analogous to modeling clay than to building blocks.

The question of the structure of matter in general, and of the atom in particular, is a perfect example of the kind of thing with which this memorandum is concerned. Here we have a theory, the concept of the nuclear atom, which is accepted as positive knowledge on the strength of a number of supposedly incontestable items of experimental evidence. Yet when we examine each of these items carefully and critically, we find that all of them dissolve into thin air; there is no positive knowledge to be found anywhere. Even the supposed "discovery" of the atomic nucleus which originated the whole line of thought turns out to be fictitious. On critical analysis we see no reason to attribute any significance to this discovery other than that the atom itself is smaller than had been thought. Now, as a fitting climax, we see that it is quite unlikely that there is any such thing as a "part" of an atom. It is becoming increasingly evident that there are no "elementary particles" and that both the atoms and the sub-atomic particles belong to essentially the same class, a class that should be called "primary" rather than "elementary," in that these are te entities which are formed directly from the basic substance of the universe: the permissible forms, we might say, into which the basic clay can be shaped. The difference between particles and atoms is one of degree only; we may appropriately look upon the particles as incomplete atoms. "This entire theory is interesting today chiefly because it demonstrates how a false, almost ludicrous, hypothesis may explain a large body of facts, and how widely, if it is not subjected to the most rigorous experimental scrutiny, it may be accepted."[40] The foregoing comments were actually made about the phlogiston theory, but in the light of the points brought out in the preceding paragraphs it can be safely predicted that future physics

textbooks will say essentially the same thing about the theory of the nuclear atom. It is too much to expect that the raising of issues such as those covered in this memorandum will be greeted with any degree of enthusiasm. Old beliefs, like shoes, are comfortable and they are given up only with great reluctance. But if the insistent demands for "radical changes" and "basic conceptual innovations" that emanate from our foremost theorists are to be met, many of these old beliefs must be sacrificed, no matter now distressing the parting may be. As Sir George Thomson expresses it: "There is some new item wanted to make these new pieces [mesons, etc.] fall into place in the puzzle... when the idea comes it may very probably involve a recasting of fundamental ideas and the abandonment of something that we now take completely for granted."[41]

This memorandum is not intended to specify which of the old beliefs should be abandoned, or what should replace them. Rather it is addressed to the prerequisite task of pointing out which of the old beliefs are vulnerable; that is, which of them have no sound factual basis and therefore could be erroneous. Of course, it has been necessary in some instances to go a step farther and show that some currently popular ideas, such as the nuclear atom and the conversion of hydrogen to helium in the stars, are almost certainly wrong, but the primary thesis of the discussion is that general acceptance is no guarantee of the validity of a theory; all too often this acceptance is based merely on the lack of anything better, rather than on the merits of the theory itself. The principal point which it is intended to emphasize is that the new and improved basic theory that is so fervently desired must conflict with some of these ideas that owe their present standing to general acceptance rather than to factual proof, and it may, indeed it probably will, conflict with many of them. It therefore follows that such conflicts, as long as they are confined to items of the categories herein enumerated, do not constitute valid arguments against any new theory that may be proposed, and they should not be allowed to block consideration of new theories. An open mind toward conceptual innovations is particularly important under conditions such as those that now exist: "*...It must be recognized,*" says John A. Wheeler, "*that the present situation calls for a certain daring in consideration and testing new ideas.*"[42]

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CHAPTER 3

The Invention of Modern Physics

Five thousand years ago, when the invention of writing on clay tablets by the Sumerians first gave the human race an opportunity to leave a permanent record of its thoughts and actions, there was already in existence a rather sophisticated science of astronomy. The priests, who were the scientists of those days, were not only familiar with elementary astronomical facts, such as the apparent movements of the sun, moon and planets, but they had also advanced to the point where they were able to predict eclipses and to calculate the length of the year to within about a half hour of its present accepted value. The premises upon which these calculations and others of the same kind were made were the fundamentals of the science of that day, in the sense in which I am using the term now, that is, they were the most basic of the principles that were used by the science of that day.

These principles were originally derived by a simple application of what we now call inductive reasoning; that is, they were generalizations from experience. And that is the most reliable method of arriving at scientific principles, fundamental or otherwise, but unfortunately, it is limited by the amount of empirical information that's available, and by the extent to which that information has been analyzed. So the result is, that an inductive science, such as that of the ancient peoples, has a tendency to fall behind the progress of empirical discovery, and ultimately it acquires a rather embarrassing accumulation of unsolved problems. Now that was the situation in Egypt, in Babylonia and in the Far East about three thousand years ago.

The time was clearly ripe for some new approach, and that was provided by a remarkable group of thinkers who flourished in Greece during the Golden Age of that country's history. The source of order in the universe, these men said, was mind, and the proper way of

arriving at general principles was to apply insight and reasoning. The result of that change in policy was to concentrate attention on the causes of physical phenomena rather than on the phenomena themselves. Where the Egyptians saw only the fact that a rock falls if it's released from a height, the Greeks looked for the cause of the fall. Now they reasoned that everything must have its natural place, so the rock in falling is merely seeking its fixed natural place. In this way, by providing an explanation for what happened, they remedied the chief defect of the previous inductive theories. Similarly they reasoned, as professor Meyer indicated, that while the earth is obviously imperfect, the heavens are perfect. And all heavenly motions must then take the perfect form, that of a circle. So the orbits of the planets are undoubtedly circular.

Now observation and experiment were definitely relegated to a secondary position by the Greeks, but they were not disregarded altogether. So when the observations showed that the planetary orbits are not exactly circles, it was recognized that there was an awkward discrepancy that we have to do something about. But one of the strong points of an inventive science, such as that of the Greeks, is that it can easily accommodate new discoveries simply by more invention. Greek method of deriving scientific principles by pure invention is that it lends itself readily to the assimilation of new information by means of more invention: so they assumed that the planets move in small circles, called epicycles, and these epicycles them move around the main planetary orbit. Then, when further observational refinement disclosed still more discrepancies, those could be taken care of in exactly the same way, merely by adding more epicycles.

The Ptolemaic theory of planetary motions is typical of inventive theories in general. Since we are able to see it in the light of historical perspective, an examination of this theory gives us a good view of the logical status of all inventive theories. The first point to be noted is that the theory was mathematically correct, within the then current limits of observational accuracy. This is true of inventive theories in general because they are deliberately designed to fit mathematical relations already known. The second significant point is that the Ptolemaic theory was conceptually wrong. Its *interpretation* of the

mathematics was not correct. This, too, is an inherent characteristic of invented theories. They are *all* conceptually wrong, because of the circumstances under which they originate. As many observers have pointed out, scientific problems do not remain unsolved because of a lack of technical competence on the part of those who are trying to solve them, or because the methods available for dealing with them are inadequate. The lack of success, where it exists, is due to the absence of some essential piece or pieces of information. In the days of the ancient Greeks, two such items were missing from what was known about the planets: the fact that the planets revolve around the sun rather than around the earth, and the existence of a gravitational force controlling the motions. Without these two pieces of information the Ptolemaic theory could never be conceptually correct, no matter how many epicycles were added. The point to be emphasized is that the same considerations apply to *all* inventive theories. If the essential information is available, it is not necessary to resort to invention; the needed theories can be derived inductively. If the essential information is not available, the theories that are invented to agree with the known mathematical relations cannot be conceptually correct.

In view of the practically unlimited opportunities for making additional *ad hoc* assumptions to meet any situation that may arise, an inventive science never reaches the kind of a situation that causes the downfall of inductive sciences. At any given time there may be a few items for which plausible explanations have not yet been invented, but there is never the large accumulation of unexplained phenomena that characterizes an inductive science that has fallen behind the progress of empirical investigation. However, the freedom to meet new requirements by adding more and more *ad hoc* assumptions, or epicycles, leads to a fate of a different kind. The time ultimately comes when such a system of theory simply has too many epicycles.

In the meantime, even though the fundamental theories in current use are inventive, the accumulation of empirical information and the construction of inductive generalizations of a lower rank continues. Ultimately, a point is reached where the principles derived inductively are sufficiently broad in their scope to challenge

the premises of the prevailing inventive theories. The Greek system reached this point about 500 years ago, and science then reverted to the inductive status, discarding inventive concepts such as the perfection of the heavens and the natural places of physical entities in favor of principles formulated by such men as Kepler and Newton through inductive reasoning from observed and measured facts.

With the benefit of all the empirical information accumulated during the approximately 2,500 years since the demise of the earlier inductive systems of the ancient civilizations, the new inductive science was a vastly improved product, and it scored some remarkable successes. At one time its practitioners were quite confident that a complete understanding of the universe was within their grasp. But here, again, the inherent inability of an inductive system of theory to keep pace with the progress of empirical discovery asserted itself. Eventually, Newtonian physics was confronted with a series of discrepancies for which it had no plausible answers. Another reversal of policy took place, and the inductive science of Newton and his contemporaries was replaced by a science based on invented principles, just as the first inductive sciences were replaced 3,000 years earlier by the inventive system of the Greeks.

When an idea or system of ideas gains general acceptance and becomes a familiar feature of current thought, its origins recede from view, and it is quite likely that many a reader may be reluctant to believe that the basic theories of modern physics – the relativity theory, for instance – belong in the same category as the Ptolemaic theory of astronomy. But all of them belong in the category of pure inventions. The originators of the modern theories do not deny this; indeed, they emphasize it. Einstein, for example, saw the general acceptance of his theories in just the way that I have described: a victory of inventive science over inductive science. In his opinion, pure invention is the only way in which true fundamental principles can be derived. Einstein was highly critical of Newton's attempts to derive such principles inductively. He said this:

> Newton, the first creator of a comprehensive, workable system of theoretical physics, still believed that the basic concepts and laws of his system could be derived from experience.... the tremendous practical success of his doctrines may well have prevented him

> and the physicists of the eighteenth and nineteenth centuries from recognizing the fictitious character of the foundations of his system.[1]

Einstein's own view was that the "basic concepts and laws of physics" (what I am calling the fundamentals) are "in a logical sense free inventions of the human mind."[1] He elaborates this view in this statements:

> Since, however, sense perception only gives information of this external world of "physical reality" indirectly, we can only grasp the latter by speculative means.[2]

The theoretical scientist is compelled in an increasing degree to be guided by purely mathematical, formal considerations in his search for a theory, because the physical experience of the experiment or cannot lift him into the regions of highest abstraction.

> The axiomatic basis of theoretical physics cannot be extracted from experience but must be freely invented..."[3]

There is a rather general tendency to assume that Einstein and the other architects of modern science were not actually as casual about the background of their theories as these words would indicate; that their basic principles must have been anchored to something solid at some point. But this is not true. As Rudolf Carnap puts it, these theories were "constructed floating in the air, so to speak."[4] Einstein gives us enough information about some of his concepts to make it clear that when he talks about "free invention" he means exactly that. For example, the propagation of radiation plays a very important part in his theories, and his comments about the explanation that he invented to account for the mechanism of propagation and its relation to space are therefore very significant. In one of his books he tells us that the formulation of a theory to account for this phenomenon is a very difficult task, and he concludes with this statement:

> Our only way out seems to be to take for granted the fact that space has the physical property of transmitting electromagnetic waves, and not to bother too much about the meaning of this statement.[5]

The point of all this is that the invented theories of present-day science have exactly the same logical standing that the Ptolemaic

theory of astronomy, the "natural place" theory of gravitation and the other theories invented by the Greek scientists had in their day. They are mathematically correct but conceptually wrong.

This statement may seem to be in direct conflict with the many confident assertions in scientific literature to the effect that the fundamental theories of modern physics are established beyond the shadow of a doubt. But if one examines the basis for these assertions, one finds that the evidence that is cited is purely mathematical. What has been established is that the theories produce the correct mathematical results. Like all other inventive theories, they have been specifically designed to produce these correct results. But none of them is unique. In each case there are alternatives that produce the same result. And, as Richard Feynman points out, there is no scientific criterion by which we can choose between any two of these alternatives "because they both agree with experiment to the same extent. So two theories, although they may have deeply different ideas behind them, may be mathematically identical, and then there is no scientific way to distinguish them." He goes on to say that "every theoretical physicist who is any good knows six or seven theoretical representations for exactly the same kind of physics."[6]

What Feynman does not say is that these comments apply only to invented theories; they have no relevance to theories derived by induction from factual premises. The kinetic theory of gases, for instance, is an inductive theory. It explains gas laws in terms of the motions of the molecules of which the gases are composed. No one knows a half dozen other representations of these gas laws that are equally correct, or even one such alternative. Because it is tied in to experience – physically as well as mathematically—the kinetic theory is unique. It is both mathematically and conceptually correct. Inventive theories in general, including modern theories such as relativity and the quantum theories, are mathematically correct but conceptually wrong. This is not because of any errors in their construction, but by reason of their inherent nature.

Whether there is any net gain in using inventive theories during times when the scientific community would otherwise have no theories at all to account for some of the important observed phenomena is an interesting philosophical issue. Inventive theories are not actually

necessary. The mathematics, which always antedate the theories, could be used equally well without any theoretical explanation. So the issue boils down to the question: Is a wrong explanation better than no explanation at all? There is a widespread tendency, dating back at least to Francis Bacon, to answer this question affirmatively, the argument being that a plausible explanation, even if wrong, will suggest some lines of further investigation that may be productive. On the other hand, it is easy to see that insistence on adhering to Aristotle's inventive theories was a serious impediment to scientific progress, particularly in the latter years of the ascendancy of Greek science. It can logically be deduced that insistence on adhering to the modern inventive theories is having a similar effect today.

In any event, the fact that now needs to be recognized as we approach the twenty-first century is that we have once more arrived at the kind of situation that developed in the Middle Ages. The currently accepted fundamental physical theories derived by pure invention have come to be overloaded with epicycles, while coincidentally the development of inductively-based theory has caught up with the empirical discoveries, so that the way is now open for a return to the firmly-based inductive type of science.

The imminence of another policy reversal could easily be deduced from nothing more than a consideration of the times involved in the cycle of reversals just described. The first inductive sciences prospered for thousands of years before they were overthrown by the Greek inventive science. The first inventive science then endured for about 2,500 years before the second of the inductive sciences, the one commonly associated with the name of Newton, took over. The accelerating pace of science is evident in that only about four hundred years later this vastly improved inductive science was replaced by the second inventive science, the one now in vogue. Almost a hundred years more have elapsed. On the basis of a continuation of the same accelerating trend, it would be safe to predict, even without the benefit of any additional information, that another reversal of policy is now due. The fundamental principles of twenty-first century science probably will be those of a third inductive science – rather than the inventive concepts of twentieth-century physics.

But we do not have to depend entirely on inferences of this kind, as there is plenty of direct evidence leading to the same conclusion. The epicycles already have multiplied to the point of absurdity. The history of the quantum theories, for example, consists of a long series of modifications and conflicting interpretations which have made the theoretical structure practically unintelligible. Feynman, who should be in a position to assess the situation, tells us flatly, "I think I can safely say that nobody understands quantum mechanics."[7]

The situation with respect to atomic structure is similar. The most popular pastime in physics today is inventing properties by which the characterize quarks, the elusive particles of which the constituents of the atom supposedly are constructed. No one has ever seen, or otherwise observed, a quark, or anything that could be a quark. Indeed, one of the most urgent objectives of the theorists is to produce a plausible theory that will justify asserting that quarks are inherently unobservable. Nevertheless, we are told just what kinds of quarks can exist, and what their properties are: properties with such interesting names as color and charm.

In order to put this situation in the proper perspective, we should realize that while quarks have never been observed, the particles that are supposed to be constructed of quarks have never been observed either. Of course, these particles, the hypothetical constituents of atoms of matter, are called by familiar names, such as "electron." But as we saw earlier the properties that a particle must possess in order to play the part of the hypothetical electron in the atom are altogether different from those of the electron that is observed experimentally. There is actually no adequate justification for calling them by the same name. As Professor Herbert Dingle points out, we can deal with the electron as a constituent of the atom only if we ascribe to it "properties not possessed by any imaginable objects at all."[8]

This question of atomic structure provides a good example of the difference between induction and invention. Such men as Newton and Einstein recognized the difference very clearly. Newton emphasized that he did not employ invention ("*hypotheses non fingo* – I frame no hypotheses"), while Einstein condemned Newton's inductive approach. But both procedures start in the same way – with a hypothesis – and this has confused the issue for many individuals. The difference lies

in what happens when the hypothesis has been tested and found to be wrong. The Newtons then either discard the hypothesis, or modify it drastically. The Einsteins invent something that eliminates the discrepancy so that they can retain the original hypothesis.

When it was first discovered that atoms disintegrate under appropriate conditions, and emit particles in so doing, the hypothesis that the atom is constructed of such particles was very plausible. But, as we have seen, when this hypothesis is put to a test it fails, because the emitted particles are not capable of forming an atom. The inductive scientists, the Newtons, then have to abandon the hypothesis of an atom composed of particles, and try to formulate some other hypothesis. But the inventive scientists, the Einsteins, add some epicycles – they simply assume whatever is necessary to make the particles fit the requirements – and they retain the original hypothesis. This is the situation that exists today. Present-day theorists are obsessed with the idea that they must continue to subdivide matter until they come to an elementary unit. So they invent atomic constituents; they invent forces, such as the ”strong force” to hold these invented constituents together; they invent quarks from which to construct the invented constituents, and there is even a suggestion that it may be necessary to invent a sub-quark—the so-called superstrings of infinitesimal length and zero width. The particles of physics are rapidly approaching the status of the fleas in the popular little verse:

> *Big fleas have little fleas*
> *Upon their backs to bite ’em.*
> *The little fleas, still smaller fleas,*
> *and so on, ad infinitum.*

When we reach the point where further sub-division cannot be accomplished without invention, as is now the case with the atom, this tells us that the atom is not composed of smaller units of matter, but is composed of some other more fundamental entity. We will take up the question as to the identity of this entity shortly.

In the meantime, let us return to the question of inventive versus inductive science. While the position of the prevailing inventive science has been deteriorating, a large number of individual advances

in different physical fields have extended a solid framework of inductive theory far beyond the level at which it stood in the early twentieth century. Scientific knowledge at that time was too limited to provide the necessary foundation for an inductive theory of the far-out regions into which observation was beginning to penetrate. This was the reason, of course, why inventive science gained the ascendancy. A few of the essential building blocks were already in place. The discrete nature of the units of radiant energy had been demonstrated, radioactivity had been discovered, electric current had been identified as a movement of electrons, and so on. But an immense amount of additional information had to be accumulated. That information is now available, and the final addition to the inductive structure needed to make it capable of dealing with the entire body of current empirical knowledge as it now stands has been provided by a new theoretical development. This development is the subject of my published works, and those of my associates; its basic outlines will be presented in part II of the present publication.

As often happens in scientific research, this theoretical advance was an unexpected result of a project aimed at a totally different objective. This project, begun a half century ago, attempted to devise a way of calculating physical properties, or at least some of them, from the chemical composition. In some respects this is a rather unfavorable subject for investigation—it has had a great deal of attention from previous investigators, and the most promising lines of approach have been rather thoroughly combed over. On the other hand, it is problem for which an answer certainly exists, since the physical properties of different substances obviously are results of their chemical composition.

I started with the concept embodied in the periodic table of the elements: the idea that the principal properties of these elements depend on the two variables represented vertically and horizontally in the tables. The first real advance that I made, after many false starts, was a recognition of the fact that one of these variables assumed both positive and negative values, whereas the other was always positive. Then, after much additional time and effort had been applied, it became evident that there were three of these principal variables rather than only two.

While these efforts to establish the form of the mathematical relations were under way, I was also struggling toward an understanding of the meaning of the mathematics. A tie-in to physical reality was necessary if the results were to be conceptually correct. Here, again, my first efforts followed conventional lines of thought.

The prevailing view was, and still is, that the differences between the properties of the chemical elements are due to variations in the number and arrangement of the sub-atomic particles of which these elements' atoms are assumed to be composed. My original course of procedure was directed toward accounting for the mathematical relations on this basis. Continued lack of success forced me to consider other alternatives. One of the possibilities that I eventually visualized was that some of the variability might be due to differences in the motions of the constituent particles rather than to differences in the atomic composition. This approach was likewise unsuccessful, but it did produce some indications that I was on the right track. These indications became stronger when I placed more emphasis on motions and less on composition. Eventually, the idea that some of the variability might be due to differences in the motions was discarded, and it was substituted by the idea that such differences are responsible for all of the variations.

This was the first really radical conceptual jump in the development of my thought, and it had some significant consequences. When the variability was ascribed entirely to differences in the motions, the existence of only three major variables made it quite clear that the motions must be motions of the atom rather than motions of many atomic constituents. Then, since inherent motion of the atom is almost certainly rotation, the number three naturally suggested rotations around the three perpendicular axes. The magnitudes of the three major variables could then be identified with the speeds of the three rotations. On this basis, the entity of which atoms of matter are composed, according to the conclusions reached earlier, is motion, and the atom is simply a combination of motions. The concept of an atom composed of subatomic particles now had to be discarded.

With this understanding of the general nature of the atomic structure, the stage was set for the final inductive step of the original project. Among the mathematical expressions that I had derived

during the twenty years or more that I had already been working on the project were some interesting expressions relating certain physical properties of the elements directly to their atomic numbers. What I now had to do was to put these expressions in terms of motions. This was another long, and often frustrating, task. But after several more years in which I examined every possibility that I could think of, plausible or implausible, it finally dawned on me that one of the most intriguing of the mathematical expressions that I had formulated, one that related the inter-atomic distances of the elements in the solid state to their atomic numbers, could be very easily explained if there were a general reciprocal relation between space and time.

If anyone who encounters this idea for the first time finds it rather weird, I can understand their reaction. It struck me that way too. My first impression was that the idea of the reciprocal of space was conceptually absurd. But when I took a closer look at this concept, I could see that it was not so unreasonable after all. The only relation between space and time of which we have any definite knowledge is motion. And in motion, space and time are reciprocally related. So I examined further the consequences of such a relation. I found, much to my surprise, that it led directly to simple and logical solutions for at least a half dozen longstanding problems of physical science.

Anyone who has ever done research work will understand that this is the kind of a breakthrough that we visualize in our most rosy dreams, and, of course, it called for the initiation of a full-scale investigation to see just how far this clarification of the physical picture would extend. By the time of my first publication, in 1959, I had been able to formulate a set of postulates, incorporating the reciprocal concept. I could show that the principal features of the major subdivisions of physical science could be obtained by pure deduction from these postulates, without the aid of any supplementary assumptions or any information from experience. In the years since the initial publication, scientists in all parts of the world have joined in the effort. The scope of the deductive system has been increased to the point where we can predict that it will ultimately achieve the objective that Newtonian science once envisioned: It will encompass the entire physical universe.

For those who shudder at the thought of having to subject their scientific beliefs to a complete overhaul, I want to say that even though the new theoretical system rests on a different foundation, in most instances it arrives at the same conclusions as conventional theory. I would estimate that ninety percent of what now passes for scientific knowledge is incorporated into the new system either just as it stands, or with nothing more drastic than a change in the language in which it is expressed. Another five percent or so retains the mathematics in the existing form, but alters the interpretation. Not more than five percent of conventional scientific thought has to undergo any significant change, and these major reconstructions are confined to the far-out regions: the realms of the very small, the very large and the very fast, the same regions in which conventional science is encountering its most serious problems.

On first consideration, it may seem strange that totally different basic premises would lead to much the same results in so many cases. There is, however, a very simple explanation. The ninety percent of present-day science that is incorporated into the new deductive system without significant change is not derived from the general principles invented by Einstein and other modern physicists. It is derived empirically. The theories included in the ninety percent are the inductive theories of lower rank than the fundamental principles I have been discussing. What the new system of theory does in these areas is to provide a general theoretical basis for the empirically-derived relations, something that has never been available before.

As I pointed out in the discussion of the Ptolemaic theory, the construction of an inductive theory is impossible if some essential piece of information is missing. When observation and measurement were extended into what I have called the far-out regions, Newtonian science lost the battle to Einstein and his inventions because the essential piece of information that would have enabled understanding the situation in these far-out regions was not available. We have now identified it.

The piece of information that has been missing until now is the reciprocal relation between space and time. By applying this relation we have been able to construct a new inductive science on a specific

and definite basis. Our problem now is to bring this development to the attention of the scientific community. Here we encounter the same obstacle that always faces innovators. Those who take a superficial look at the new development see only the fact that it challenges some popular ideas. They hold up their hands in horror and say: "These people disagree with Einstein. They must be crazy." I have yet to find any law of science that prohibits disagreeing with Einstein, but be that is it may, since this is such a common reaction, let us look at the situation and see just where this disagreement lies.

Einstein changed the course of science by developing his two theories of relativity—first the special theory, published in 1905, which applies only to uniform translational motion, and more than a decade later the general theory, which applies to accelerated motion. Peter Bergmann makes this comment about the relationship between the two:

> It is quite true that the general theory of relativity is not consistent with the special theory any more than the special theory is with Newton's mechanics – each of these theories discards, in a sense, the conceptual framework of its predecessor.[9]

So it is impossible to agree fully with both the general theory and the special theory. Actually, few front-rank scientists have much confidence in the general theory in spite of the lip service that is paid to it by the scientific community at large. Bryce DeWitt, one of the leading investigators in the gravitational field, which the general theory is supposed to cover, said categorically, "As a fundamental physical theory general relativity is a failure." P. W. Bridgman predicted that "arguments which have led up to the theory and the whole state of mind of most physicists with regard to it may some day become one of the puzzles of history."[10] Thus, while we must concede that we disagree with the general theory on many counts, this is not much out of line with the most advanced scientific opinion.

Whether or not we disagree with the special theory, on the other hand, depends on just how this theory is defined. Bridgman comments that there is a tendency to "define the content of the special theory of relativity as coextensive with the content of the Lorentz equations."[11] Paul K. Feyerabend, a prominent philosopher of science, puts it in this manner:

> It must be admitted, however, that Einstein's original interpretation of the special theory of relativity is hardly ever used by contemporary physicists. For them the theory of relativity consists of two elements: (1) the Lorentz transformations; and (2) mass-energy equivalence.[12]

On this basis, we do not disagree with the special theory at all. We are in full agreement with both the Lorentz equations and the mass-energy equivalence. The conclusions that so many physicists have reached in accepting the mathematical relations and rejecting Einstein's interpretations are the same conclusions that I have previously noted as applying to all inventive theories. Such theories are all mathematically correct and all conceptually wrong. Thus, if anyone actually examines the situation, instead of merely reacting emotionally, he will find that we disagree with Einstein's relativity theories only in the same way that general scientific opinion also disagrees with them. What we reject are all of the unsubstantiated inferences that are currently being drawn from these theories, because our new development enables us to distinguish valid from invalid inferences. The existence of speeds greater than that of light is an outstanding example.

Earlier we examined the case of a particle accelerated to a very high speed by a presumably constant electrical force: its acceleration decreases at a rate which will reduce it to zero at the speed of light. Since Newton's relation between force, mass and acceleration is merely a definition of force, the decrease in acceleration at high speeds must be due either to an increase in the mass or to a decrease in the force. There is no physical evidence to indicate which alternative is correct. Einstein simply assumed an increase in the mass. Our theoretical development now indicates that he made the wrong choice, and that the decrease in acceleration is actually due to a decrease in the effective force.

At the time Einstein made his choice there was nothing to indicate that it makes any real difference which of these alternatives is correct. Either one leads to some kind of a speed limitation. It is not likely, therefore, that Einstein gave the matter any extended consideration. But since our new development now indicates that speeds in excess

of that of light definitely do exist, a review of the situation is obviously required. If Einstein's assumption of an increase in mass were correct, the limit at the speed of light would be absolute, as the mass would be infinite at that speed. But on the basis of our finding that what actually takes place is a decrease in the effective force, the limit is not on the speed, but on the capability of the process. All that the experiments actually show is that it is impossible to accelerate a physical object to a speed greater than that of light by electrical means, a conclusion that we also reach theoretically. But this does not preclude acceleration to higher speeds by other means, such as powerful explosions.

By accepting Einstein's denial of the existence of speeds greater than the speed of light as gospel that cannot be challenged, modern science has closed the door on the answers to some of the most significant problems of the present day. It is this mistake that has caused astronomy to become more fantastic than science fiction, with its neutron stars, black holes, white holes and all of the other extravagances. I have noted recently that quark stars have now joined this list. When the reciprocal relation between space and time is recognized, the need for all of this fictional science, as we may call it, is eliminated. The phenomena of the far-our astronomical regions can be explained on the same matter-of-fact basis that applies in our everyday world.

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CHAPTER 4

The Historical Perspective

The foundation of my theoretical system is a rigorous definition of space and time which specifies that these entities are the two reciprocal aspects of motion, and have no other significance. This is the only basic innovation that I have introduced into physical science. Indeed, the entire subsequent development could be accurately characterized as nothing more than an investigation of the consequences of this new space-time definition. Thus the logical status of the new theoretical system as a whole is determined by the status of the reciprocal relationship.

This redefinition of space and time is a very radical deviation from current scientific thought, and the system of theory that I have derived from it has therefore been handicapped from the start by the usual human reluctance to give countenance to, or to become identified with, heretical doctrines of any kind. I am therefore pleased to be able to report that as a result of further investigation of physical fundamentals I am now able to show that the new space-time definition is not heretical at all. On the contrary, it is a natural and logical extension of a line of thought that has been actively pursued by a host of scientists and philosophers, including some of the most eminent men in these professions, over a period of at least three or four hundred years. In fact, it can be said that the space-time definition that I am proposing is implicitly contained in the premises upon which all of this previous work was based.

The justification for all of the immense amount of effort that has been applied to this particular line of investigation lies, of course, in the fact that physical theory, as now constituted, is not, and never has been, able to keep pace with scientific progress. It is true that physical science has made a spectacular record of accomplishment on the basis of the present structure of theory, a record that has no

parallel in other areas of human thought. But the continuing advance of knowledge places new and more stringent demands on the theoretical structure, and these demands are not being met. It should not be necessary to enter into any extended discussion of this point, inasmuch as the inadequacy of existing theory is generally conceded, even by those who have been most active in its development. As Richard Feynman puts it, "We are in some kind of trouble."

The main cause of this trouble is not hard to find. Before we can construct an accurate theory of anything, we must have—least a reasonably good idea as to the nature of the thing about which we are theorizing. This, physical science does not have. The accepted idea is that we live in a universe of matter – a universe in which the basic entities are units (particles) of matter existing in a setting or framework provided by space and time – and this idea is clearly wrong. Although the fact is not yet generally recognized, primarily because no one wants to face the issue, the "matter" concept of the universe has been completely demolished by the modern discovery that matter can be transformed into non-matter, and vice versa. Obviously this is conclusive proof that matter is not basic. There must be some common denominator underlying both matter and nor-matter. However reluctant scientists may be to part with it, the concept of a universe of matter is no longer tenable, and sooner or later it will have to be abandoned, along with those portions of existing theory that are wholly dependent on this concept.

Since we are in trouble, and we know why, the next question that arises is: What are we going to do about it? What can be put in the place of this erroneous concept of a universe of matter? Oddly enough, the most likely answer to this question has been known for centuries. It has long been recognized that some very substantial advantages would accrue from replacing the "matter" concept with the concept of a universe of motion: one in which the basic entities are units of motion rather than units of matter.

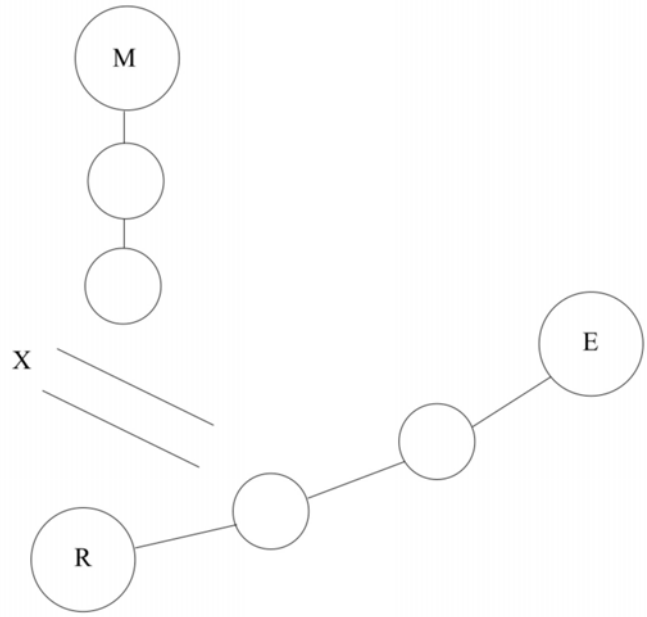
As so many previous investigators have realized, a physical theory based on the "motion" concept would be comprehensive; that is, it could embrace such items as radiation and electrical phenomena which are an acute embarrassment for present-day "matter" theory, inasmuch as they are neither matter nor part of the background in which matter is presumed to exist.

Furthermore, a theory based on the "motion" concept could account for the behavior of physical entities as well as for their existence. When we formulate a theory or set of theories to explain the existence of such entities on the "matter" basis, we must construct another set of theories to explain how they behave, but a theory based on the "motion" concept can explain not only what these entities are but also what they do. Then, too, the "motion" concept brings us closer to an ultimate understanding of the universe. If we postulate a universe of matter, we are immediately confronted with the question, What is matter?, a question that has never been fully or satisfactorily explained. But we think that we have an intuitive understanding of what motion is.

So we are in trouble, we know why, and we know the most promising way out of our difficulties. Why, then, is no structure of theory based on the "motion" concept available? The answer is that hundreds of years of painstaking effort by competent scientists and philosophers – such men as Eddington, Hobbes, and Descartes, as well as a multitude of less prominent individuals – have been unsuccessful, and no workable theory of a universe of motion has heretofore been constructed. These previous investigators have started with the premise that we live in a universe of motion – "all things have but one universal cause, which is motion," says Hobbes unequivocally – and have attempted to build upon this foundation, but they have invariably encountered an obstacle which they have been unable to surmount, or even to identify, and their most strenuous efforts have been fruitless.

For a great many years I have been poking around in the dark corners of science, and in the course of this activity I have discovered the nature of the obstacle that has blocked the way of those who have sought to develop a physical theory on the "motion" basis. The situation can be represented graphically by this diagram:

Eddington, *et al.,* have started with the concept of a universe of motion M, and have followed a line of thought based on this concept, but have encountered some unidentified obstacle X, and they have been unable to take the next logical step to the crucial conclusion R, which would have enabled them to construct a theory on the "motion" basis. However, in the course of my investigations I have arrived at this crucial conclusion R from a different direction, starting from empirical premises E, and



following a purely mathematical route. Having reached the conclusion R, I was then able to look back and determine the nature of the obstacle X that blocked the way of those who attempted to reason directly from the postulate of a universe of motion.

In this way I have found that the formidable obstacle which frustrated the best efforts of all of the earlier investigators was their failure to realize that switching from the concept of a universe of matter to the concept of a universe of motion requires a redefinition of space and time. In a universe of matter, the basic definition – the definition of matter – does not define space and time, and these entities must therefore be defined independently. All of the previous investigators have assumed that independent definition is also required in a universe of motion But this is not correct. In a universe of motion the basic definition – the definition of motion – also defines space and time, and in such a universe no independent definitions are possible.

Motion is defined as a relation between space and time, and is measured as speed or velocity, the mathematical expression of that relation. The equation of motion in its simplest form is v=s/t. As

can be seen from this equation, the standard definition of motion in terms of space and time is also a definition of space and time in terms of motion; that is, in motion, space and time are the two reciprocal aspects of that motion, and nothing else.

In a universe of matter, the fact that space and time have only this limited significance with respect to motion does not preclude them from possessing other aspects in connection with phenomena of a different character, as present-day theory assumes. But in a universe of motion, where all physical entities and phenomena are manifestations of motion, the role of space and time in motion is their role in the universe as a whole. They cannot have any properties or any significance that they do not have in motion. Space and time can be three-dimensional, as my theory requires, if motion itself is three-dimensional. They can exist in discrete units only, as the theory also requires, if motion exists only in discrete units. But they cannot constitute a setting or background for motion, because motion is not a background for itself. Everywhere in the physical universe space and time are the two reciprocal aspects of motion, and they have no other significance anywhere. This is the crucial conclusion represented by the symbol R on the diagram.

Thus, as I said earlier, the new definition of space and time is implicit in the concept of a universe of motion. If Eddington and other earlier investigators who attempted to build a physical theory on the concept of a universe of motion had seen the situation more clearly they would have recognized that once they postulate that motion is the basic constituent of the universe, they are automatically committed, whether they like it or not, to this new definition of space and time. Inasmuch as the entire system of theory that I have outlined in my published works is merely a detailed development of the consequences of redefining space and time in this manner, it follows that this theoretical system is a necessary and unavoidable result, to the extent that the development has been correctly and accurately carried out, of the concept of a universe of motion. It is the result that the previous investigators inevitably would have reached if their outlook had not been so severely limited by the traditional view of the nature of space and time from which they were unable to break away.

CHAPTER 5

The Missing Factor

In 1964, Dr. Richard Feynman gave a series of lectures at Cornell University in which he discussed the nature and extent of our knowledge of physical fundamentals. These lectures were later published in book form with the title *The Character of Physical Law.* In the book we find this assertion:

"Every one of our laws is a purely mathematical statement,"

and also this:

"Today our theories of physics, the laws of physics, are a multitude of different parts and pieces."

The fragmented nature of this basic knowledge is due to the fact that these physical laws have not been derived from any central source. As Feynman puts it, "We do not have one structure from which all is deduced." Instead, the laws applicable to different physical areas have been derived independently, each from the empirical information available with respect to that particular field. To those who have not had occasion to make any critical study of this situation it may seem natural and logical to handle the derivation in this piecemeal manner, in view of the lack of the kind of a general theoretical framework that could serve as a base from which to deduce the laws. In fact, however, it has been possible to use this kind of an approach only because of a peculiarity of mathematical knowledge.

None of the mathematical formulations of these laws is known to be unique. In many, perhaps most, cases there are known alternatives that lead to the same answers (within the accuracy to which they can currently be tested), and in all cases it is obviously possible that there are alternatives as yet unknown. But in mathematics, different formulations that lead to the same answers are not different mathematical expressions; they are merely different ways of stating the same expression, and

they are interconvertible. It follows that just as soon as we obtain a mathematical formulation that yields the correct answers, we have the valid mathematical relation or law. Working on this basis, the cumulative efforts of a host of investigators over long years of research have given us a body of mathematical laws and relations that, we can feel confident, correctly represent, within current limits of accuracy, the physical entities and relations with which we deal.

There is, however, another side to the physical picture. We are not satisfied to know only the mathematical aspects of the physical world. We also want a physical interpretation of these mathematics, an explanation of what the mathematical terms and relations mean. So, in addition to the mathematical knowledge that has been accumulated, we are also attempting to build up a corresponding knowledge of what we may call the conceptual aspects of the physical universe. Here, again, the lack of any general theoretical foundation has forced the scientific community to resort to the piecemeal, area by area, method of deriving its results, and here, too, those results take the form of "a multitude of different parts and pieces."

As in the mathematical situation, the conceptual formulations that fit the known facts within the current limits of accuracy are not unique. Indeed, far more conceptual than mathematical alternatives are known, and here again it is always possible that there are other alternatives as yet unknown. In the realm of conceptual knowledge, alternative formulations that arrive at the same results are not different forms of the same theory; they are different theories. Only one of them can be correct, even though all of them are in agreement with the observations. We have no way of identifying this correct alternative. It follows that a conceptual theory or conclusion cannot be verified by agreement with observation.

Obviously, the statement of a mathematical relation tells us nothing about the physical meaning of that relation. In fact, this mathematical statement gives us no indication that it has any connection with physical existence. The names that may be attached to the mathematical statement are part of the conceptual structure, and have no mathematical significance, hence they do not participate in the verification of the validity of the mathematical relation. Thus, a conceptual theory or conclusion cannot be verified mathematically.

No other method of verification has been available. It is true that there is another method that is theoretically possible. The number of alternative explanations of an interconnected set of physical phenomena decreases as the number of different phenomena included in that set increases, because each extension of the diversity imposes new constraints on the possible explanations. It follows that if a fully integrated conceptual theory of a large and highly diversified set of physical entities and phenomena could be constructed, a positive correlation with observation would establish its validity on a probability basis. But long-continued efforts have failed to produce any such far-reaching theory. As matters now stand, therefore, conventional science has no way of validating the conceptual conclusions that it has reached in the physical field.

This does not mean that all of the currently accepted laws and relations are conceptually wrong. On the contrary, the majority of them are probably correct, as there are indications of various kinds that serve to identify some alternatives as more probable than others. However, it does mean that there is no proof of the validity of any of these laws and relations, and it indicates that there is sufficient probability of error in each case to make it evident that many of the formulations are not valid, particularly where a long sequence of successive conclusions is involved.

Although the scientific community has closed its eyes to this situation and refuses to recognize that the so-called "proofs" of validity that it offers – such as the contention that mathematical agreement establishes conceptual validity – are untenable, there is a widespread recognition of the fact that the status of theoretical physics would be greatly improved if a physical theory of wide applicability could be constructed. This point was recognized quite early in the history of scientific investigation. It was also realized that such a far-reaching theoretical structure would almost certainly have to be based on an understanding of physical fundamentals. For almost three thousand years, therefore, one of the prime goals of science has been to derive a general physical theory, one by means of which the answers to all physical questions can be derived from a single set of basic premises.

In spite of all of the effort that has been applied to the search over this long period of time, there has been no appreciable progress toward the goal. Physical knowledge remains as characterized by Feynman: a multitude of separate pieces. Attempts have been made to connect some of the pieces by means of assumptions, but the need for an assumption identifies a discontinuity. It does not establish a connection. The question then arises, Why has this long and determined effort failed to reach its objective?

Although practically nothing is said about this subject in the current scientific literature, there is really very little doubt as to where the difficulty lies. A theory is no better than its foundations, and the foundation upon which the investigators are attempting to build a general physical theory is faulty because the true nature of the basic physical entities is almost entirely unknown. The electric charge, for instance, is basic to a wide range of phenomena, but the physicists cannot answer the question: What is an electric charge? The textbooks tell us merely that we should not ask the question. The nature of time is even more mysterious, and the same uncertainty is present in some degree in our knowledge of all of the entities that are treated as fundamental in the development of theory.

These basic entities are the ultimate physical units, the foundation stones on which theory must be erected. Even though we do not have actual knowledge as to their nature and properties, we must nevertheless use them in the theoretical development. We must therefore make assumptions, and substitute them for the knowledge that we do not have, in order to have something with which to work. Most of these basic entities enter into almost every physical process in one way or another. As a consequence, each of the "multitude of different parts and pieces" that in total constitute the conceptual structure of physical theory rests, in part, on some or all of 30 or 40 assumptions about unknown or poorly known basic physical constituents.

No doubt many of these assumptions are correct expressions of the physical facts. Perhaps most of them are. But it is totally unrealistic to expect that all of these many assumptions about the elusive basic entities are valid, and any error in the foundations of the structure of theory invalidates, in whole or in part, all of the theoretical conclusions that rest on these foundations. It is thus evident that the "parts and pieces" of modern physical theory must contain many errors.

Ordinarily it can be expected that the imperfections in observational knowledge will be gradually eliminated, or at least minimized, as further observations and measurements are accumulated. But observation of the basic entities is severely limited, and scientific investigation has not been able to gather much more direct information about them than is available to the casual observer. Many changes in the assumptions about these entities have been suggested during the course of the various investigations that have been undertaken, and some of them have gained general acceptance. There is a widespread tendency to regard this general acceptance as the equivalent of proof, but in fact, an assumption is never more than guesswork, regardless of the extent of its support. Substituting one assumption for another may or may not bring us closer to the truth. In any event it adds nothing to our actual knowledge of the phenomena to which the assumptions apply. The changes in the accepted assumptions have not added anything to our actual knowledge of the conceptual aspects of physical phenomena.

As a result of the long-continued inability to increase factual knowledge of the basic entities it has been generally conceded that the prospects for any advance of this kind are very dim. Most scientific opinion now appears to accept Einstein's dictum that the true nature and properties of the fundamental physical entities are not only unknown, but unknowable. He specifically condemned the idea that "the basic concepts and laws of physics could be derived from experience," and asserted that they could only be grasped "by speculative means." The issue has thus receded into the background, and at present remains dormant.

As it happened, however, after the observers had given up hope and had discontinued active search for more factual information about fundamentals, some new developments have taken place. A number of the new discoveries in the far-out regions of physical science that have been made in recent years have given us the kind of direct observational information about basic entities that science has so long sought. But because the scientific community is no longer looking in this direction, it has not recognized what has now been revealed.

One of these significant new developments is the discovery of the interconvertibility of some of the basic entities. We now know that, under appropriate conditions, mass can be converted into kinetic energy, this energy can be converted into electric charge, and so on. In order to be completely interchangeable – that is, convertible from one to the other without adding or removing anything, as these entities are – such entities must necessarily be nothing more than different forms of the same thing. They are different forms of some common denominator, we may say. The observations thus show that electric charge, kinetic energy, and matter (of which mass is a property) are not separate and distinct phenomena, but are different forms of something basic. Either two of them are forms of the third, or all are forms of some still more fundamental entity.

Although the long search for the ultimate constituent of the physical universe has been unsuccessful in its primary objective, it has added to our knowledge of the situation by including a thorough examination of the suitability of the various known basic physical entities as candidates for the status of the ultimate constituent. The net result of this intensive scrutiny has been to eliminate all but three of the possibilities. These are (1) motion, (2) energy, and (3) some currently unknown entity. Alternatives (2) and (3) no longer have any significant support, and for many years the general conclusion has been that if there is a single basic constituent of the physical universe it must be motion.

The advantages of motion for this fundamental role are so obvious that even on the basis of the limited amount of evidence now available, many prominent scientists and philosophers have been fully convinced that the physical universe is a universe of motion. Thomas Hobbes, for instance, stated categorically that "all things have but one universal cause, which is motion." But these supporters of the motion hypothesis have not been able to translate their belief into a general physical theory, or even to make a reasonably good start toward such a theory. The search for a unifying constituent has therefore come to a halt, and has had little attention in recent years. Current research is directed toward a search for the ultimate constituent of matter, rather than for the ultimate constituent of the universe.

Here, again, one of the recent observational discoveries has thrown an entirely new light, not yet recognized in conventional physical thought, on the situation. It has been found that the distant galaxies are all moving radially outward from each other at high speeds. Unless we assume that our Milky Way galaxy is the only stationary object in the universe, a hypothesis that is rejected by modern science, it must be receding from all of the others. If these were ordinary vectorial motions, oppositely directed motions would cancel each other, and the net result would be little or no actual change in position. But the galactic separations are increasing rapidly, and if our galaxy is not unique we must be participating in the changes of position that cause the increase in separation. Thus we are actually moving outward in all directions from any initial position. This means that the recession motions of the galaxies have no specific direction. They are simply outward (that is, positive) and each can be completely described by a positive magnitude. They are scalar motions.

The galactic motions are currently attributed to an "expansion" of the universe, but whatever they are called, and however they may originated, observations shows that they are a scalar motions. Once the existence of scalar motion anywhere in the universe is established, it follows that this type of motion is one of the constituents of the physical universe. Inasmuch as it is obviously simpler than vectorial motion (which is scalar motion plus a direction) it is more fundamental. If the physical universe is a universe of motion, as the results of long years of investigation seem to indicate, the ultimate constituent of that universe must therefore be scalar motion.

Vectorial motion, the motion of our ordinary experience, is motion with a direction relative to the spatial reference system being used, usually either the absolute Newtonian system or Einstein's system, in which space is distorted by the presence of mass. Scalar motion has no inherent direction, and therefore cannot be represented in its true character in a three-dimensional system of reference; that is, the successive points in the line of travel cannot be specifically identified in that system. To make a representation of some kind possible, it is necessary to introduce a one-dimensional datum, a reference point, thus converting the spatial reference frame to a combination one and

three-dimensional system. But even with this expedient, the motion is not shown in its true character. The positions that are identified are correct only for the motion relative to the reference point. In the case of the galaxies, for example, if we observe distant galaxy X from our galaxy A, we find that it is moving in the direction AX in the spatial reference system. But if we observe it from galaxy B we find that it is moving in the very different direction BX. When galaxy C is the reference point, it is moving in the direction CX. And so on.

This inability of the reference system to represent one of the basic constituents of the physical universe – scalar motion – in its true character demonstrates that the "space" of that system is not a physical entity, the kind of thing that can be "curved," or otherwise distorted, or can interact with physical matter. It is an arbitrary construction for reference purposes – nothing more. The true physical "space" is the spatial aspect of motion.

The need to call upon an expedient such as the reference point in order to make any kind of a representation of scalar motion possible in the reference system also explains why conventional science has not discovered the existence of scalar motion. Motions of this nature have not been recognized as motions. For instance, it is evident, as soon as the factors governing the representation of scalar motion in the reference system are clarified, that the inverse square forces – electrostatic, electromagnetic, and gravitational – are the force aspects of scalar motions, but they have not been recognized as such, because their observed characteristics are so different from those of vectorial motions. Here is the explanation of the physicists' inability to answer the question, What is an electric charge?

This identification of the basic physical constituent as scalar motion opens the door to construction of the long-sought general physical theory. When the possible ways in which units of this scalar motion can be disposed relative to the reference system are determined, these are found to agree, item by item, with the fundamental physical entities. Thus, in a universe of scalar motion, the true nature and properties of radiation, matter, electric and magnetic charge, and the other basic entities, are specifically and accurately defined. In this way, a solid foundation is laid on which a comprehensive general theory can be erected.

Part II

Laying the Foundations

CHAPTER 6

THE NATURE OF MOTION

When the theory of the universe of motion, the Reciprocal System of theory, as we are calling it, was first being introduced to the scientific community, in books and lectures, one of the principal obstacles with which we had to contend was the generally accepted concept of the nature of motion, in which motion is regarded as a continuous change in the position of some "thing" in a three-dimensional space that acts as a background or container. In the Reciprocal System of theory motion is defined simply as a relation between space and time, which means that "things" do not participate in the simplest types of motion. For those who were not willing to entertain the possibility that their basic concept of the nature of motion might be wrong, this closed the door to any consideration of the new theory, in spite of the outstanding successes of that theory in dealing with the most recalcitrant and long-standing problems of physical science.

In the years that have followed, our activities aimed at promoting understanding of the theory have been directed primarily at those who are open-minded enough to recognize that the need for conceptual modifications cannot be ruled out. We have therefore been engaged mainly in extending the application of the theory and clarifying those points that have been questioned. However, now that over a quarter of a century has elapsed, a new generation of scientists is coming in contact with these ideas, and the earlier questions about the basic concepts are resurfacing. A review of the fundamental situation therefore appears to be in order at this time.

The history of science clearly demonstrates that long-continued existence of a major scientific problem is rarely due to the lack of

adequate methods of dealing with such problems, or to deficiencies in the abilities of the investigators. Almost without exception, when such a problem is finally solved it is found that the obstacle that has so long stood in the way of solution is an error in one of the fundamental concepts on which the previous thought has been based. Before any significant progress could be made it was necessary to change the conceptual base from which the problem had been viewed.

This is always a difficult undertaking. For example, the idea of inertia seems almost self-evident today, and even a schoolboy is able to grasp it. But, as Herbert Butterfield points out in his book *The Origins of Modern Science,* until the days of Galileo and Newton the problem that was finally solved by the formulation of this concept "defeated the greatest intellects for centuries." The then prevailing view of the nature of motion—the theory developed by Aristotle—"was hard for the human mind to escape from ... because it was part of a system which was such a colossal intellectual feat in itself." Butterfield goes on to say:

> We have to recognize that here was a problem of a fundamental nature, and it could not be solved by close observation within a framework of the older system of ideas – it required a transposition in the mind.

This experience with Galileo's discovery illustrates the fact that we actually know very little about the basic structure of the universe. The concepts on which thinking about such subjects is based are not products of scientific investigation and research. They are the ideas that our early ancestors derived from observation of the world about them, and they have achieved their present unquestioning acceptance only because they have remained unchallenged for so long a time. When we subject them to a critical examination we find that they are not, in fact, derived directly from empirical observations. Instead, they are assumptions suggested by those observations.

For example, we know practically nothing about the nature and properties of time. We have a vague impression that it is some kind of a moving forward, and that is all that we have to work with. But time enters into every physical activity in one way or another, so in order to deal with those activities, we have to make assumptions

about the properties of this almost totally unknown entity. Not one of these assumptions is free from doubts. Physical theory assumes that time is unidirectional, and one of our important physical principles, the Second Law of Thermodynamics, is based on this assumption, but the mathematics of motion are equally consistent with a reverse flow. The theory assumes, in nearly all applications, that the flow is uniform, but Relativity theory, which challenges this assumption in its field of application, is also generally accepted. The theory assumes that time is one dimensional, but the investigators working along the outer boundaries of science are continually advancing hypotheses that call for the existence of additional time dimensions.

Little more is actually known about the nature and properties of the other basic physical entities. The physicists cannot answer such questions as "What is matter?" or "What is an electric charge?" And the validity of the assumptions that are made about these entities is just as doubtful as that of the assumptions about time. No doubt many are valid statements of the physical facts. Perhaps most of them are. But it is totally unrealistic to take the stand that all of the assumptions that have been made about these poorly understood basic physical entities – at least 30 or 40 assumptions in all – are factual. And no one knows which ones are wrong. Furthermore, an error in one of these fundamental assumptions necessarily results in many errors in the structure of thought that rests on the fundamentals Thus there is no justification for rejecting a new theory simply because it conflicts with any existing ideas or beliefs, or even if it conflicts with many aspects of previous thought. A conflict with the observed facts is, of course, fatal, but a conflict with previous theory, or assumption, is something that should be considered on its merits.

In Aristotle's concept of motion it was assumed that continuous application of a force is necessary for production of a continuous motion. Galileo's conclusion from his experiments was that this assumption is wrong, and that motion continues on the same basis indefinitely unless a force is applied to change it. Direct verification of basic assumptions of this kind by means of observations is impossible, but we can develop the consequences of each of the rival assumptions and see which set of consequences agrees more closely with those observations. On this basis, Aristotle's concept

was ultimately disproved and abandoned, after long and acrimonious controversy with those who refused to concede any possibility that their long-standing beliefs might be in need of revision.

The same kind of a situation now exists with respect to those aspects of motion that are redefined by the Reciprocal System of theory. Just as Galileo met an obstinate adherence to the dictum that "Continuous motion cannot exist without continuous application of force," so we are now told, just as positively, that "Motion cannot exist without something moving." Both of these confident pronouncements are pure assumptions. Neither has any support from observation. Indeed, both are specifically contradicted by modern astronomical observations. The motions of the planets, for instance, are incompatible with Aristotle's assumption. Similarly, the motions of the galaxies flatly contradict the assumption that underlies the 20th Century motion concept.

The following assumptions enter into this concept:

1. The space and time that we observe constitute a container, or background, for the action of the universe.
2. All existences occupy specific locations in that space and time.
3. Motion is a change of location of some "thing" in that space during an interval of time.

The status of assumption 3 has always been somewhat dubious, in spite of its general acceptance, because there is no trace of the "something" in the mathematics of motion. It serves only to identify the motion under consideration. Where the motion can be identified in some other manner, the mathematics are equally applicable. The recent discovery of the recession of the galaxies has provided a definite refutation of the assumption. It is now generally conceded that the recession is not a movement of the galaxies themselves. The astronomers are agreed that they are being carried outward by what is called the "expansion of the universe."

This expression merely describes what is occurring; it does not explain anything. But whatever the nature of the "expansion" may be, it clearly must apply to all locations in space, not merely to those that are occupied by galaxies. Here, then, is a motion that is not a motion of any entity that could be called a "thing." Thus the contention that

there cannot be motion unless some "thing" is moving is refuted by actual observation. However, for the benefit of those to whom this kind of motion presents conceptual difficulties, we can legitimately say that it is motion of spatial locations. Each galaxy remains in a particular location, but the locations move outward.

Assumption 2 is likewise invalidated by the observed galactic recession. Galaxy X is receding from galaxy A, and at time t occupies a position on an extension of the line AX. But X is also receding from galaxy B, and at time t it also occupies a position on an extension of the line BX. When we take the other galaxies into account, it is evident that galaxy X does not occupy any specific position in the space of a universal "container." The invalidation of assumptions 2 and 3 makes assumption 1 untenable.

When we take the other galaxies into account, we find that galaxy X occupies all positions in what we ordinarily call "space" at a certain distance from the initial point of the motion. This is obviously incompatible with the concept of "space" as a container in which each physical object has a specific location, as asserted by assumption number 1. Indeed, it can be seen that the "space" and "time" of our ordinary experience are not physical entities at all; they are merely mental constructs that constitute a reference system which we use for relating the quantities of space and time that do have an actual physical existence, those that take part in the various motions of which the universe is composed.

Furthermore, this is an incomplete reference system. It is not capable of representing the positions of the receding galaxies in their true character. It can represent only the positions relative to some reference point. Nor is this its only deficiency. Our investigations have shown that there are a number of other types of motions that, like the scalar motion of the galaxies, it cannot represent correctly, and still others, such as motion in more than one dimension, that it cannot represent at all. What we are up against here is a range of variability of physical motion (relations between space and time) that far exceeds the capability of any system of reference that has thus far been devised.

However, when the space and time of our ordinary experience, extension space, as we may call it, is viewed in its true capacity as a

reference system, it is easy to see that there is no obstacle in the way of representing a simple motion, one that is not motion of anything. As defined by the theory of the universe of motion, this simple motion is a relation between a quantity of space and a quantity of time, and is measured as speed. If we specify an initial point we can represent the amount of space corresponding to any given amount of time by a line in the reference system extending away from the initial point. Obviously, there is no need to identify this line with any "thing."

Thus the conceptual basis of the explanation of the nature of motion embodied in the postulates of the Reciprocal System is just as rational and logical as that of the currently accepted theories. It is merely different. The question as to which of the two is correct is not a matter of which one we like better. It is an issue that can be settled by the same procedure that was used to resolve the analogous question raised by Galileo; that is by developing the consequences of each hypothesis and comparing the results with the relevant observations and measurements. There can be no doubt of the verdict if all of the evidence is examined. As we have shown in our publications, the theory of the universe of motion produces the kind of a comprehensive and fully integrated general physical theory that has long been sought but never before even approached.

In looking back on the history of the development of thought with respect to the nature of motion prior to the acceptance of the concept of inertia, a striking feature of the situation is the extent to which Aristotle and his disciples were forced to call upon the actions of "angels" and other hypothetical existences to take care of gaps in their explanations of physical phenomena. As Butterfield puts it, Aristotle's universe was one "in which unseen hands had to be in constant operation." The great achievement of Galileo and Newton was to put the science of mechanics on a sound physical, rather than metaphysical, basis.

Today physics in general is in the same kind of a position that mechanics occupied before Galileo. The physicists have built a structure of rather loosely related theories that have had some spectacular successes – another "colossal intellectual feat." But like Aristotle's system, "modern physics" has many gaps in its structure, and to fill those

gaps, or at least to conceal them, the modern theorists have resorted to the same expedient that was employed by Aristotle. In their universe, too, as in his, "unseen hands" must be in continual operation.

Of course, present-day scientists do not speak of "angels" or "demons," but the mysterious "forces" of modern physics are exactly the same things under different names. They are pure inventions, designed to overcome specific difficulties in accepted theory, with no other functions to perform, and with no independent evidence of their existence (that is, no evidence other than that they agree with the observations that they were specifically designed to fit). Aside from the name, there is nothing to distinguish the "nuclear force" that holds the hypothetical nucleus of the atom together for the modern physicist from the "angels" that pushed the planets along in their paths for Aristotle. No reason is given for the existence of these strangely limited "forces," nor are we given any explanation of how they operate. "We do not ask how mass gets a grip on space-time and causes the curvature which our theory postulates," says Arthur Eddington.

The problems in mechanics could not be solved without paying the price—to many a very high price—of giving up some cherished ideas and beliefs of long standing. But the rewards were enormous. Again quoting Butterfield:

> Once this question was solved in the modern manner, it altered much of one's ordinary thinking about the world and opened the way for a flood of further discoveries… It was as though science or human thought had been held up by a barrier until this moment.

The world of science now faces the same kind of an issue. If the scientific community recognizes that a number of the basic assumptions of present-day physics have been invalidated by modern discoveries such as the recession of the galaxies and the interconvertibility of matter and non-matter, then some of the ideas that are now hailed as the "greatest achievements of science" must be discarded in favor of new – and to some, disturbing – concepts. But once more, as in Galileo's day, the door will be opened to "a flood of further discoveries."

The theory of the universe of motion, in its present stage of development, accounts for all of the major physical phenomena,

and a large and growing assortment of subsidiary phenomena as well, by pure deduction from a single set of basic premises, without the introduction of any supplementary assumptions. A particularly significant point is that this deductive development accounts for the existence of the basic physical entities – matter, radiation, electricity, etc. – as well as the properties of those entities.

In the three decades since the first publication of the theory no one has attempted to refute the foregoing statement. Those who reject the theory invariably do so on the ground that the conclusions derived from the theoretical development conflict with some of the generally accepted ideas, which, of course, they do. Sooner or later, perhaps when the devastating effect that recent empirical discoveries have had on the basic assumptions of "modern physics," are more generally recognized, the scientific community will find it necessary to face this issue rather than continuing to evade it. In the meantime we will continue extending the application of the theory into additional areas and into more detail, each step in this process adding to the already overwhelming mass of evidence confirming the validity of the development as a whole.

CHAPTER 6

Scalar Motion

Whenever a new physical theory appears, one of the first objectives of the supporters of that theory is to find a crucial experiment, an experiment whose results agree with the new theory, but are definitely in conflict with its predecessors. This is a difficult undertaking, not only because it is hard to find an experiment of the right kind, but also because the results of that experiment, if an experiment is found, can usually be accommodated to existing theory by ad hoc assumptions of one kind or another. And the scientific community prefers to accept a modified theory of that kind, in preference to an entirely new theory, even if the modifications require such wild ideas as black holes or charmed quarks. Nevertheless, a crucial experiment occasionally does make its appearance.

Perhaps the most famous was the Michelson-Morley experiment. The constant speed of light disclosed by that experiment was devastating to the Newtonian system, and created a conceptual vacuum that cleared the way for the acceptance of Einstein's relativity theories. My associates and I have naturally been on a lookout for a crucial experiment of this kind, and many leads have been followed up. I have not been not able to devise a crucial experiment, but what occurred to me was that we could reach exactly the same point by identifying some previously unrecognized result of some earlier experiment. After all, we are not interested in the crucial experiment itself. What we want is the crucial piece of information that is derived from that experiment, and it actually makes no difference whether we get that from a new experiment or an old one. The public library in my home city is currently featuring a sign that says, "A book is always new if you have never read it." The same is true of physical facts. A physical fact is always new if it has never before been recognized.

In the course of my investigations over the past forty or fifty years I have uncovered a great many hitherto unrecognized or disregarded physical facts – a surprisingly large number of them. But the one that fits our present requirements is a hitherto unrecognized property of scalar motion. Scalar motion itself is well known, although not by that name. For example, when the recession of the distant galaxies was first discovered some years ago, the astronomers needed an analogy to help explain the nature of that motion, and they knew right where to look for it. Almost every such explanation reads something like this one, which was taken from a current astronomical text: The common analogy likens the galaxies to spots on the surface of a balloon that is being inflated. As the rubber stretches, all the spots move away from each other. The widespread use of this analogy testifies to the general understanding that the motion of the spots on the expanding balloon and the motion of the distant galaxies is, in some way, different from ordinary motion; but the importance of that motion is not seen to be sufficient to justify any systematic exploration of its properties. After all, nobody is very much worried about the physics of expanding balloons. But that situation was changed very drastically by the development of the theory of the universe of motion, because scalar motion plays a very important part in that theoretical structure. So it was necessary for me to undertake the full-scale investigation of scalar motion that had not hitherto been attempted.

If we examine the motion of the spots on an expanding balloon in isolation, without placing the balloon in a reference system, or introducing a reference system into the balloon, or if we construct a similar mental picture of the recession of the distant galaxies, there is no way by which we can distinguish the motion of any one spot or of any one galaxy from the motion of any other. Each spot and each galaxy is simply moving outward away from all others at a constant rate of speed. That motion has only one property—a scalar magnitude. Such a motion is, by definition, scalar. The scalar motions readily accessible to observation are not isolated in the manner of those I have mentioned, but are connected to a physical reference system in some manner, as for instance by placing the balloon on the floor of a room. That physical coupling to the reference system provides the

directions that the motions themselves do not have. If the coupling is fixed, so that the directions are likewise fixed, then the combination of a scalar motion and a coupling to the reference system behaves in most respects in the same way as an ordinary vectorial motion, and it is not currently distinguished from a vectorial motion.

Here is a place where a very important point has been overlooked. It is recognized that the balloon can be placed anywhere in the room, and it follows that the motion of any particular spot can take any direction in the reference system. But what has *not* been recognized, or at least not clearly recognized, is that the ability to take any direction is not limited to a constant direction. For example, the balloon may be rotated. The effect of a continuous rotation of the coupling to the reference system is to distribute the scalar motion over all directions in the dimension or dimensions of rotation, thus producing a distributed scalar motion. The properties of that distributed scalar motion are quite different from the properties of combined vectorial motions in different directions. In vectorial motion the magnitude and the direction are interrelated. For example, if a vectorial motion of magnitude X in a specific direction is superimposed on a vectorial motion of equal magnitude in the opposite direction, the resultant is zero. Similarly, vectorial motions of equal magnitude in all directions add up to no motion at all. But the magnitude of a distributed scalar motion is not altered by the changes in direction.

The balloon example is a relatively unimportant motion, originated and maintained by human action. But the fact that such motions exist means that the same kind of motions may originate from natural causes. So we thus arrive at the conclusion that there probably exist somewhere in the physical universe a class of distributed scalar motions that are not currently recognized as motions.

As soon as we reach that conclusion, it is almost immediately apparent that the reason for the lack of recognition is the prevailing attitude toward the concept of force. Force is defined for scientific purposes as the product of mass and acceleration. Motion itself is measured, on an individual mass-unit basis, as speed or velocity. That is, each individual mass-unit moves at that rate. On a collective basis, it is measured as the product of mass and velocity, which is currently called momentum, but in earlier days was known by

the more descriptive name of quantity of motion. The time rate of change of the motion is an acceleration on the individual mass-unit basis, and the product of mass and acceleration, or force, on the collective basis. This obviously means that force is specifically defined as a property of motion; and it follows that force cannot be autonomous in the manner in which the so-called fundamental forces of nature are currently regarded. Every fundamental force is a property of a fundamental motion. But that creates problems for present-day science. For example, the electric charge produces an electrical force, and so far as we can tell it produces that force directly, with no sign of any intervening motion of the kind that is required by the definition of motion. Present day science handles that problem very simply—by ignoring it. But if we want to actually resolve the problem, what we need to do is to identify the electric charge as a distributed scalar motion. The charge itself is the motion, so we don't need that intervening motion that we don't find.

This process of identification is a necessary part of all scientific work, because the entities with which we deal don't come equipped with labels. The process itself is simple enough. It operates on what is sometimes called the 'duck principle.' You are familiar with that, I presume? If it looks like a duck, and it swims like a duck, and it waddles like a duck, and it quacks like a duck, then it's a duck. We can illustrate the application of that principle by a simple example. Out in the depths of space we see certain objects that we call stars and planets. It is not obvious from visual observation what those stars and planets are – at one time it was thought that they were simply holes in the sky that let the light shine through. Since then the properties of matter have been determined, where we are in direct contact with it, and some of the properties of the stars and planets have also been determined. The two have been correlated, and whenever a comparison has been made, they have been found to be identical. That justifies us, on the basis of the duck principle, in concluding that the stars and planets are aggregates of matter.

In exactly the same way we are identifying the electric charge as a distributed scalar motion. This is the same conclusion that I reached earlier in my theoretical works; but the situation is now entirely different. That theoretical conclusion had no meaning to

anyone who was not willing to accept the premises on which it was based; and any scientist, or anybody else for that matter, had the option of accepting or rejecting it. That option is no longer open. We have now demonstrated that the identity of an electric charge as a distributed scalar motion is a necessary consequence of positively established facts, and the scientist has no option but to live with the facts.

The discovery and identification of distributed scalar motion was, in itself, an important advance in knowledge, but it also opens the door to a better understanding of the entities that can now be identified as distributed scalar motions. One important point that has been clarified is the existence of multi-dimensional motion. Vectorial motion is one-dimensional. It may extend into three dimensions of space, but as motion it is confined to one dimension. Any such motion is described by a vector, which is one-dimensional; and any number of these vectors can be combined into a resultant vector, which is likewise one-dimensional. But scalar motions in different dimensions cannot be combined in any way analogous to the addition of vectors. It follows that scalar motions in different dimensions are independent. An n-dimensional motion, mathematically speaking, is simply one that requires n magnitudes for a complete definition. Thus a one-dimensional motion, or other physical quantity, can be defined by one magnitude; a three-dimensional scalar motion requires three magnitudes for its definition. One of those magnitudes, and only one, can be further subdivided by the introduction of directions relative to a spatial reference system. That motion can then be defined by a vector, and it can be represented in the spatial reference system by a line.

Current scientific thought regards the whole of existence, physical existence at least, as being contained within the space and time of the spatial reference system. And that current thought denies the existence of what I have just been talking about; that is, multi-dimensional motion. But now that we have derived the existence of multi-dimensional motion from established physical facts, it is evident that this current scientific opinion, which was never anything but an assumption, is an erroneous assumption. What we now find is that the conventional three-dimensional spatial reference system is capable of representing only a limited portion of the total contents of the universe.

With the benefit of this information as to multi-dimensional motion, we can now complete the definition of the basic distributed scalar motions. A study of the properties of electric charges, which I will include in the new publication, but won't take the time to go into here, shows that the charge is a one-dimensional distributed scalar motion. A similar study of gravitation shows that gravitation is a three-dimensional distributed scalar motion. The situation with respect to magnetism is not as clear cut, because it is complicated by the existence of electro-magnetism, which is a phenomenon of an entirely different kind. But we can identify the so-called permanent magnetism as a two-dimensional distributed scalar motion.

In present-day thought these phenomena are dealt with as fields, but just what constitutes a field has always been a matter of a considerable difference of opinion. From Marshall Walker we get this definition: "A field is a region of space where a test object experiences a specific force." But Einstein disagrees. Einstein says a field is something "physically real" in space, "for the modern physicist as real as the chair on which he sits." This difference in opinion as to the nature of the field is further complicated by differences of opinion as to how the field theory ought to be applied and as matters now stand, the whole status of the theory is in considerable doubt. From David Park we get this assessment of the situation: "This does not mean that the ultimate explanation of everything is going to be in terms of fields, and indeed there are signs that the whole development of field theory may be nearer its end than its beginning." The clarification of the scalar motion situation shows that the field is neither a region of space as indicated by Walker, or something like the physicist's chair, as indicated by Einstein. It is simply a distributed force. The force aspect of a vectorial motion is a vector; the force aspect of a distributed scalar motion is a field.

The failure to recognize important facts, such as the existence of distributed scalar motion, has a double effect in that it encourages the development of erroneous theories, and then causes a disregard of the facts that disagree with those theories. The situation with respect to gravitation is a good example. The observed facts with respect to gravitation are well known, and they are almost entirely disregarded. As nearly as can be determined from observation, gravitation acts instantaneously, without an intervening medium,

and in such a way that its effects cannot be screened off or modified in any way. But those properties are so difficult to explain on the basis present-day theory that the physicists have resorted to the unusual expedient of constructing a fictitious set of properties that they can explain, and substituting those fictitious properties for the observed properties. Notwithstanding all evidence to the contrary, present-day physical opinion insists that gravitation must be propagated at a finite velocity, through a medium, or something with the properties of a medium. Einstein, of course, made space a medium – gave it the properties, as he said, of a medium. It is freely admitted that there is no evidence to support this present-day contention. As one prominent physicist puts it, "Nowadays we are also convinced that gravitation progresses with the speed of light. This conviction, however, does not stem from a new experiment or a new observation; it is a result solely of the theory of relativity." Once it is recognized that gravitation is a distributed scalar motion, all necessity for this defiance of the facts is removed, because the properties of a distributed scalar motion are exactly those properties of gravitation that have proved so difficult to understand.

The insistence on viewing gravitation as a transmission process also involves a wholesale disregard of the physical facts. That viewpoint likens gravitation to electromagnetic radiation, and we hear about gravitational waves in the same way that we hear about electromagnetic waves. But the two processes are entirely different, and it is very difficult to understand why anyone should ever connect the two. Electromagnetic radiation is an energy transmission process. A photon leaves an emitting object with a certain amount of energy. The energy of the emitting object is decreased by that amount. The photon travels through space and reaches an absorbing object, delivers the energy, and the energy of the absorbing object is increased by that amount. The intervening space, the distance, has nothing to do with the process, except in determining the time it takes for travel. The process is independent of the distance. In contrast to that process, the gravitational process is totally dependent on the distance. If there is no change in the distance, that is, if the two apparently interacting objects don't change their separation, then there is no change in the energy at all. And even if an energy change does take place, as

happens in a case of an object falling towards the Earth, the increase in the kinetic energy of the incoming falling object is not obtained at the expense of the Earth: it's derived from the potential energy, the energy of position, of the falling object itself. Much the same considerations apply to electricity and magnetism.

There are a number of other direct consequences of the scalar motion existence that have an important bearing on various physical problems, and I intend to cover them, that is, all those that I have so far identified, in this new book; but I don't want to take the time to talk about them here, because I want to leave time for adequate consideration of another very important finding, which, like the existence of distributed scalar motion, is significant enough to justify classifying it as the equivalent of the results of a crucial experiment.

This second important finding is a result of a well-known experiment, but it has not previously been recognized because a recognition of distributed scalar motion was a prerequisite for recognition of the new fact. As a preliminary, before starting to talk about that particular subject, I want to say a few things about speed limits. The present scientific view is that nothing physical can move faster than the speed of light. That belief is based on Einstein's interpretation of certain experiments in which an electric force was applied to the acceleration of light objects, such as electrons. It was found in those experiments that the acceleration did not continue at the same rate as might be expected from Newton's second law of motion, but decreased at high speeds at a rate which indicated it would reach zero at the speed of light. That indicated, of course, that either the force must decrease at high speeds, or the mass must increase. There is no physical evidence of any kind to indicate which is the correct alternative, so Einstein had to make a guess, and he guessed in favor of the mass alternative. According to his theory the mass increases at high speeds and becomes infinite at the speed of light. On this basis it is, of course, impossible for any higher speed to exist.

So far as present-day theory is concerned, it makes little difference which of these alternatives is correct, because there is obviously a limit on a one-dimensional basis in either case. Since present-day theory does not concede the existence of multi-dimensional motion, the existence of a one-dimensional limit is equivalent to the existence

of a limit on speeds in total. But when we recognize the existence of multi-dimensional scalar motion, then it's equally evident that the limit on speed in one dimension can be reached in each of the three dimensions. That does not mean that it's possible to achieve a speed greater than light by electrical means, because, as I pointed out a little bit earlier, the electrical force is one-dimensional. That accounts for the fact that the electrical force was unable to reach any higher speed. But it does not preclude acceleration to higher speeds by means of some other process, such as, for instance, the release of large quantities of energy in violent explosions.

This brings me down to that second important physical fact that I have been discussing. We know from observation that the electric charge occurs only in discrete units. We have identified the electric charge as a distributed scalar motion. Now there's no difference between this scalar motion and any other scalar motion so far as the motion itself is concerned: the difference is only in the nature of the coupling to the reference system. Once we have established that the electric charge, which is a scalar motion, is limited to discrete units, it then follows that scalar motion occurs only in discrete units. Those who are encountering that conclusion for the first time may not be very much impressed by it. But those familiar with the Reciprocal System of theory will realize the great significance of deriving this conclusion from purely factual premises. At one stroke it raises a very substantial portion of the conclusions that have been reached with respect to a universe of motion from the status of theoretical conclusions to the status of established facts.

The only property of a scalar motion is magnitude; such a motion is a relation between a space magnitude and a time magnitude. Now we have further found that those are integral magnitudes, so that the properties of scalar motion are the properties of integral magnitudes. It then follows that we can derive the physical properties of scalar motion under any particular circumstances by translating the mathematical properties of reciprocal integers, which we already know, into the appropriate physical language. This, of course, is a general principle of extremely wide application.

In our ordinary view of motion the minimum amount of motion is zero; and zero is therefore the condition of rest, the condition from

which effective magnitudes are measured. In a reciprocal speed system, on the other hand, the minimum speed is unity, because anything less than unit speed is not speed: it's inverse speed. Similarly, the minimum inverse speed is unity. It follows that in such a system unit speed is the condition of rest, the condition from which all speed magnitudes are measured. Expressing that in another way, we can say that unit speed is the natural reference system. The natural reference system for scalar motion is not a fixed system; it is a moving system.

The motion of the time component is universally recognized. We all recognize that "now" is not something that stays put. It continually moves forward. The essence of the new finding is that "here" is an entity of the same kind: it likewise continually moves forward. What this means, then, is that all physical objects are continually being carried outward at unit speed relative to the fixed reference system.

In most cases that outward motion cannot be recognized; but where the gravitational effect is absent, as in the case of the photons of radiation, we can observe the outward motion: photons move outward at the speed of light. The same is true where the gravitational effect is practically negligible, as in the most distant galaxies, which are likewise moving outward at almost the speed of light. Another important consequence of the reciprocal relation that we have now established is the symmetry around unit speed which means that there is motion in time as well as in space. An increase in the time, while the space is constant, results in a decrease in space per unit time, and therefore causes a change of position in space. An increase in space with time remaining constant decreases time per unit space and causes a change of position in time. So here we arrive at the concept of a motion in time. This concept is perfectly familiar to those of you who have been dealing with the theory of a universe of motion; and a great deal of what I am saying now is very much the same as I was saying years ago when I was first explaining that theory. So it's old stuff to you. But it has a quite different significance in the present context. The extent to which we can now derive these conclusions from established facts greatly strengthens the position of the theory. Many individuals have rejected our conclusions without any serious consideration simply because they conflict with ideas of long standing that have had no basis other than assumptions to begin

with. But now that we are able to show that these conclusions are consequences of positively established facts, that option, as I said with regard to another item, is no longer open. Scientists have no option but to accommodate themselves to the facts.

The system of scalar motions that we can represent in the spatial reference system, the one-dimensional motion that I was talking about earlier, can be duplicated in time because of this space-time symmetry, so that we have another system equivalent to the scalar motion system that is represented in our reference frame. The derivation that I am giving you now deals only with scalar motion, and we'll have to leave vectorial motion for consideration at some other time, because I haven't brought that within the factual limits yet. But we can consider this point: that gravitation is a scalar motion, and that consequently all gravitating objects are included in the inverse system. This includes all material objects. It follows that the inverse system is at least co-extensive with the system that is open to observation, whether or not it is an exact duplicate. The inverse system that I have been talking about is a system of maximum speed. The system that we are well acquainted with, that we deal with on our ordinary reference system, is a region of minimum speed.

Now I want to take a brief look at some of the things that happen in the intervening area. First, we need to look at some of the primary processes that are involved. The progression of the natural reference system is outward, a plus or positive motion in our usual language. It is limited to one unit, because that is the maximum that we can have in a system of discrete units. Gravitation is capable of extending to two units before it reaches a net resultant of one negative unit; and to that one negative unit we can apply outward translational motion in one dimension. Here we again have a range of two units. The same is true in each of the three dimensions. That gives us then a total separation of six units of speed from one zero to the other.

So far I have been talking about full units. Of course, when we exclude fractional units, we don't have anything but full units, but we can produce the equivalent of a fractional unit by adding units of the opposite kind, that is, units of motion in time. N units of motion in time are equivalent to minus 1/n units of motion in space – so that we accomplish a resultant of less than one unit by combining the

one full unit with the oppositely directed fractional unit from the other direction. This is the first speed range, the range from zero to one unit. It is the range of our ordinary experience, the speed range that's represented in the spatial reference system. It's not possible, obviously, to exceed one unit by any kind of a subtraction from a single unit, which accounts for the limitation on the speed in one dimension. But there is nothing to prevent the addition of another full unit, so that in the next speed range, we have two units minus a fractional unit. The same is true in the third speed range.

It's necessary to keep in mind that the first of the two units is a unit of space and that there is a unit of time in the same dimension. There is a unit of space from zero space to unity, which is the unit of both space and time, and another unit from this unit level to zero time. Thus, the second unit of motion is in time. Then, in order to add a third unit, we have to go to a second dimension, so that again we have a dimension of space. On this basis the speed from zero to one unit is in space. That's the ordinary motion that we are acquainted with. A speed from one unit to two units is in the same dimension, but it is in time. A speed from two units to three units continues that unit of speed in time, but adds a unit of speed in space, so that it's two-dimensional.

These are the major characteristics of high-speed motion as we derive them from the reciprocal relationship that we have just found. In order to give this a meaning in terms of our physical observations, we have to resort to the identification process again. The most energetic processes that we know of in the universe are explosions of stars and galaxies. If any objects with speeds in these intermediate ranges that I have been talking about actually exist, they must exist as objects of that kind. So let's look at them. All violent explosions generate some low-speed products, and we see those low-speed products expanding away from the site of the explosion, usually at high speeds. Those products are not of particular interest to us now because they are in the lower speed range, the ordinary speeds of our everyday experience. But in motion in the second speed range, the change of position is in time. So that the motion in that speed range produces the same kind of a cloud of expanding particles, but this time they are expanding into time. Because of the reciprocal relation between space and time that I have just been talking about, the cloud of particles expanding into time decreases in

size as seen in the spatial reference system, so that we observe such a cloud of particles as a very small object of a very high density, which remains in essentially the original location. Such an object can, of course, be identified with the stars that we know as white dwarfs. So here, then, we can identify objects in which the speeds are in the second speed range – from unity to two units. This is another conclusion we reached theoretically, but now we find that we have sufficient evidence to establish it as a consequence of positively established facts.

We also have evidence that there are explosions of galaxies, and since these are very much larger objects – our own galaxy contains something like ten to the eleventh power solar masses, a hundred billion times the size of one star – the explosion of a galaxy is very much more violent, we can therefore deduce that some of the products of that explosion will probably enter the third speed range. As I pointed out a short time ago, that should have two consequences. Because it has a two-dimensional motion, one dimension of which is in time and another in space, that kind of an object will be moving rapidly outward, as well as decreasing in size, like the white dwarf star. Such an object will therefore be the equivalent of what we might call a white dwarf galaxy; not a galaxy composed of white dwarf stars, but a galaxy that has the properties of white dwarfs. We can easily identify this as one of the objects known as quasars.

Now, to summarize what I said: I have not been able to find the kind of a crucial experiment that I and others have been looking for. But by means of a systematic analysis of previous experimental work, I have uncovered two hitherto unrecognized facts of a crucial nature – the kind of facts that would have been obtained from crucial experiments, if I had found such an experiment, or two of them. These new crucial facts are, first, the existence of distributed scalar motion, and, second, the limitation of all scalar motion to discrete units. With the benefit of these new crucial items of information, many of the unique features of a universe of motion, including multi-dimensional motion, motion in time, speeds greater than that of light, and a second half of the universe, can now be presented to the scientific community as established facts, rather than as theoretical speculations. This should aid very materially in the continuing effort to secure the serious consideration that has thus far been so difficult to obtain.

CHAPTER 8

The Dimensions of Motion

Now that the existence of scalar motion has been demonstrated, it will be appropriate to examine the consequences of this existence. Some of the most significant consequences are related to the dimensions of this hitherto unrecognized type of motion. The word "dimension" is used in several different senses, but in the sense in which it is applied to space it signifies the number of independent magnitudes that are required for a complete definition of a spatial quantity. It is generally conceded that space is three-dimensional. Thus three independent magnitudes are required for a complete definition of a quantity of space. Throughout the early years of science this was taken as an indication that the universe is three-dimensional. Currently, the favored hypothesis is that of a four-dimensional universe, in which the three dimensions of space are joined to one dimension of time.

Strangely enough, there does not appear to have been any critical examination of the question as to the number of dimensions of motion that are possible. The scientific community has simply taken it for granted that the limits applicable to motion coincide with those of the spatial reference system. On reviewing this situation it can be seen that this assumption is incorrect. The relation of any one of the three space magnitudes to a quantity of time constitutes a scalar motion. Thus three dimensions of scalar motion are possible. But only one dimension of motion can be accommodated within the conventional spatial reference system. The result of any motion within this reference system can be represented by a vector (a one-dimensional expression), and the resultant of any number of such motions can be represented by the vector sum (likewise one-dimensional). Any motions that exist in the other two dimensions cannot be represented.

Here again we encounter a shortcoming of the reference system. In our examination of the nature of scalar motion we saw that this type of motion cannot be represented in the reference system in its true character. The magnitude and direction attributed to such a motion in the context of the reference system are not specifically defined, but are wholly dependent on the size and position of the object whose location constitutes the reference point. Now we find that there are motions which cannot be represented in the reference system in any manner. It is therefore evident that the system of spatial coordinates that we use in conjunction with a clock as a system of reference for physical activity gives us a severely limited, and in some respects inaccurate, view of physical reality. In order to get the true picture we need to examine the whole range of physical activity, not merely that portion of the whole that the reference system is capable of representing.

For instance, gravitation has been identified as a scalar motion, and there is no evidence that it is subject to any kind of a dimensional limitation other than that applying to scalar motion in general. We must therefore conclude that gravitation can act three-dimensionally. Furthermore, it can be seen that gravitation must act in all of the dimensions in which it can act. This is a necessary consequence of the relation between gravitation and mass. The magnitude of the gravitational force exerted by a material particle or aggregate (a measure of its gravitational motion) is determined by its mass. Thus mass is a measure of the inherent negative scalar motion content of the matter. It follows that motion of any mass m is a motion of a negative scalar motion. To produce such a compound motion, a positive scalar motion v (measured as speed or velocity) must be applied to the mass. The resultant is mv, now called momentum, but known earlier as "quantity of motion," a term that more clearly expresses the nature of the quantity. In the context of a spatial reference system, the applied motion v has a direction, and is thus a vector quantity, but the direction is imparted by the coupling to the reference system and is not an inherent property of the motion itself. This motion therefore retains its positive scalar status irrespective of the vectorial direction.

In the compound motion mv the negative gravitational motion acts as a resistance to the positive motion v. The gravitational motion

must therefore take place in all three of the available dimensions, as any one of the three may be parallel to the dimension of the reference system, and there would be no effective resistance in any vacant dimension. We may therefore identify the gravitational motion as three-dimensional speed, which we can express as s^3/t^3, where s and t are space and time respectively. The mass (the resistance that this negative gravitational motion offers to the applied positive motion) is then the inverse of this quantity, or t^3/s^3. Since only one dimension of motion can be represented in a three-dimensional spatial coordinate system, the gravitational motion in the other two dimensions has no directional effect, but its magnitude applies as a modifier of the magnitude of the motion in the dimension of the reference system.

We now turn to a different kind of "dimensions." When physical quantities are resolved into component quantities of a fundamental nature, these component quantities are called dimensions. The currently accepted systems of measurement express the dimensions of mechanical quantities in terms of mass, length and time, together with the dimensions, in the first sense, of these quantities. But now that mass has been identified as a motion, a relation between space and time, all of the quantities of the mechanical system can be expressed in terms of space and time only. For purposes of the present discussion the word "space" will be used instead of "length," to avoid implying that there is some dimensional difference between space and time. On this basis, the "dimensions," or "space-time dimensions" of one-dimensional speed are space divided by time, or s/t. As indicated above, mass has the dimensions t^3/s^3.

The product of mass and speed (or velocity) is $t^3/s^3 \times s/t = t^2/s^2$. This is "quantity of motion," or momentum. The product of mass and the second power of speed is $t^3/s^3 \times s^2/t^2 = t/s$, which is energy. Acceleration, the time rate of change of speed, is $s/t \times 1/t = s/t^2$. Multiplying acceleration by mass, we obtain $t^3/s^3 \times s/t^2$, which is force, the "quantity of acceleration," we might call it. The dimensions of the other mechanical quantities are simply combinations of these basic dimensions. Pressure, for instance, is force divided by area, $t/s^2 \times 1/s^2 = t/s^4$.

When reduced to space-time terms in accordance with the foregoing identifications, all of the well-established mechanical

relations are dimensionally consistent. To illustrate this agreement, we may consider the relations applicable to angular motion, which take a different form from those applying to translational motion, and utilize some different physical quantities. The angular system introduces a purely numerical quantity, the angle of rotation q. The time rate of change of this angle is the angular velocity w, which has the dimensions $w = q/t = 1/t$. Force is applied in the form of torque, L, which is the product of force and the radius, r. $L = Fr = t/s^2 \times s = t/s$. One other quantity entering into the angular relations is the moment of inertia, symbol I, the product of the mass and the second power of the radius. $I = mr^2 = t^3/s^3 \text{ x } s^2 = t^3/s$. The following equations demonstrate the dimensional consistency achieved by this identification of the space-time dimensions:

energy (t/s) $= Lq = t/s \text{ x } 1 = t/s$

energy (t/s) $= \frac{1}{2}Iw^2 = t^3/s \times 1/t^2 = t/s$

power (1/s) $= Lw = t/s \times 1/t = 1/s$

torque (t/s) $= \frac{1}{2}Iw^2 = t^3/s \times 1/t^2 = t/s$

The only dimensional discrepancy in the basic equations of the mechanical system is in the gravitational force equation, which is expressed as $F = Gmm'/d^2$, where G is the gravitational constant and d is the distance between the interacting masses. Although this equation is correct mathematically, it cannot qualify as a theoretically established relation. As one physics textbook puts it, this equation "is not a defining equation… and cannot be derived from defining equations. It represents an observed relationship." The reason for this inability to arrive at a theoretical explanation of the equation becomes apparent when we examine it from a dimensional standpoint. The dimensions of force in general are those of the product of mass and acceleration. It follows that these must also be the dimensions of any specific force. For instance, the gravitational force acting on an object in the earth's gravitational field is the product of the mass and the "acceleration due to gravity." These same dimensions must likewise apply to the gravitational force in general. When we look at the gravitational equation in this light, it becomes evident that the gravitational constant represents the magnitude of the acceleration at unit values of m' and d, and that these quantities are dimensionless ratios. The dimensionally correct

expression of the gravitational equation is then F = ma, where the numerical value of a is Gm'/d^2.

The space-time dimensions of the quantities involved in current electricity can easily be identified in the same manner as those of the mechanical system. Most of the measurement systems currently in use add an electric quantity to the mass, length and time applicable to the mechanical system, bringing the total number of independent base quantities to four. However, the new information developed in the foregoing paragraphs enables expressing the electrical quantities of this class in terms of space and time only, in the same manner as the mechanical quantities.

Electrical energy (watt-hours) is merely one form of energy in general, and therefore has the energy dimensions, t/s. Power (watts) is energy divided by time, t/s × 1/t = 1/s. Electrical force, or voltage (volts) is equivalent to mechanical force, with the dimensions t/s^2. Electric current (amperes) is power divided by voltage. I = 1/s x s^2/t = s/t. Thus current is dimensionally equal to speed. Electrical quantity (coulombs) is current multiplied by time, and has the dimensions Q = It = s/t × t = s. Resistance (ohms) is voltage divided by current, R = t/s^2 × t/s = t^2/s^3. This is the only one of the basic quantities involved in the electric current phenomena that has no counterpart in the mechanical system. Its significance can be appreciated when it is noted that the dimensions t^2/s^3 are those of mass per unit time. The dimensions of other electrical quantities can be obtained by combination, as noted in connection with the mechanical quantities.

As can be seen from the foregoing, the quantities involved in current electricity are dimensionally equivalent to those of the mechanical system. We could, in fact, describe the current phenomena as the mechanical aspects of electricity. The only important difference is that mechanics is largely concerned with the motions of individual units or aggregates, while current electricity deals with continuous phenomena in which the individual units are not separately identified.

The validity of the dimensional assignments in electricity, and the identity of the electrical and mechanical relations, can be verified by reducing the respective equations to the space-time basis. For example, in mechanics the expression for kinetic energy (or work) is W = ½mv^2, the dimensions of which are t3/s3 x s^2/t^2 = t/s. The corresponding

equation for the energy of the electric current is $W = I^2Rt$. As mentioned above, the product Rt is equivalent to mass, while I, the current, has the dimensions of speed, s/t. Thus, like the kinetic energy, the electrical energy is the product of mass and the second power of speed, $W = I^2Rt = s^2/t^2 \times t^2/s^3 \text{ x } t = t/s$. Another expression for mechanical energy is force times distance, $W = Fd = t/s^2 \text{ x } s = t/s$. Similarly, electrical energy is voltage times quantity, $W = VQ = t/s^2 \text{ x } s = t/s$. All of the other established relations of current electricity are likewise dimensionally consistent, and equivalent to the corresponding mechanical relations, when reduced to space-time terms.

Identification of the space-time dimensions of electrostatic quantities, those involving electric charge, is complicated by the fact that in present-day physical thought electric charge is not distinguished from electric quantity. As we have seen, electric quantity is dimensionally equivalent to space. On the other hand, we can deduce from the points brought out in the preceding chapter that electric charge is the one-dimensional analog of mass, and is therefore dimensionally equivalent to energy. This can be verified by consideration of the relations involving electric field intensity, symbol E. In terms of charge, the electric field intensity is given by the expression $E = Q/s^2$. But the field intensity is defined as force per unit distance, and its space-time dimensions are therefore $t/s^2 \text{ x } 1/s = t/s^3$. Applying these dimensions to the equation $E = Q/s^2$, we obtain $Q = Es^2 = t/s^3 \text{ x } s^2 = t/s$.

As long as the two different quantities that are called by the same name are used separately, their practical application is not affected, but confusion is introduced into the theoretical treatment of the phenomena that are involved. For instance in the relations involving capacitance (symbol C), $Q = t/s$ in the basic equation $C = Q/V = t/s \text{ x } s^2/t = s$. The conclusion that capacitance is dimensionally equivalent to space is confirmed observationally, as the capacitance can be calculated from geometrical measurements. However, the usual form of the corresponding energy equation is $W = QV$, reflecting the definition of the volt as one joule per coulomb. In this equation, $Q = W/V = t/s \times s^2/t = s$. Because of the lack of distinction between the two usages of Q, the quantity CV, which is equal to Q in the equation $C = Q/V$ is freely substituted for Q in equations of

the $W = Q/V$ type, leading to results such as $W = C/V^2$, which are dimensionally incorrect.

Such findings emphasize the point that the ability to reduce all physical relations to their space-time dimensions provides us with a powerful and effective tool for analyzing physical phenomena. Its usefulness is clearly demonstrated when it is applied to an examination of magnetism, which has been the least understood of the major areas of physics. The currently accepted formulations of the various magnetic relations are a mixture of correct and incorrect expressions, but by using those that are most firmly based it is possible to identify the space-time dimensions of the primary magnetic quantities. This information then enables correcting the existing errors in the statements of other relations, and establishing dimensional consistency over the full range of magnetic phenomena.

In carrying out such a program we find that magnetism is a two-dimensional analog of electricity. The effect of the added dimension is to introduce a factor t/s into the expressions of the relations applicable to the one-dimensional electric system. Thus the magnetic analog of an electric charge, t/s, is a magnetic charge, t^2/s^2. The existence of such a charge is not recognized in present-day magnetic theory, probably because there is no independent magnetically-charged particle, but one of the methods of dealing with permanent magnets makes use of the concept of a "magnetic pole," which is essentially the same thing. The unit pole strength in the SI system, the measurement system now most commonly applied to magnetism, is the weber, which is equivalent to a volt-second, and therefore has the dimensions $t/s^2 \times t = t^2/s^2$. The same units and dimensions apply to magnetic flux, a quantity that is currently used in most relations that involve magnetic charge, as well as in other applications where flux is the more appropriate term.

Current ideas concerning magnetic potential, or magnetic force, are in a state of confusion. Questions as to the relation between electric potential and magnetic potential, the difference, if any, between potential and force, and the meaning of the distinctions that are drawn between various magnetic quantities such as magnetic potential, magnetic vector potential, magnetic scalar potential, and magnetomotive force, have never received definitive answers.

Now, however, by analyzing these quantities into their space-time dimensions we are able to provide the answers that have been lacking We find that force and potential have the same dimensions, and are therefore equivalent quantities. The term "potential" is generally applied to a distributed force, a force field, and the use of a special name in this context is probably justified, but it should be kept in mind that a potential is a force.

On the other hand, a magnetic potential (force) is not dimensionally equivalent to an electrical potential (force), as it is subject to the additional t/s factor that relates the two-dimensional magnetic quantities to the one-dimensional electric quantities. From the dimensions t/s^2 of the electric potential, it follows that the correct dimensions of the magnetic potential are $t/s \times t/s^2 = t^2/s^3$. This agrees with the dimensions of magnetic vector potential. In the SI system, the unit of this quantity is the weber per meter, or $t^2/s^2 \times 1/s = t^2/s^3$. The corresponding cgs unit is the gilbert, which also reduces to t^2/s^3.

The same dimensions should apply to magnetomotive force (MMF), and to magnetic potential, where this quantity is distinguished from vector potential. But an error has been introduced into the dimensions attributed to these quantities because the accepted defining relation is an empirical expression that is dimensionally incomplete. Experiments show that the magnetomotive force can be calculated by means of the expression MMF = nI, where n is the number of turns in a coil. Since n is dimensionless, this equation indicates that MMF has the dimensions of electric current. The unit has therefore been taken as the ampere, dimensions s/t. From the discrepancy between these and the correct dimensions we can deduce that the equation MMF = nI, from which the ampere unit is derived, is lacking a quantity with the dimensions $t^2/s^3 \times t/s = t^3/s^4$.

There is enough information available to make it evident that the missing factor with these dimensions is the permeability, the magnetic analog of electrical resistance. The permeability of most substances is unity, and omitting has no effect on the numerical results of most experimental measurements. This has led to overlooking it in such relations as the one used in deriving the ampere unit for MMF. When we put the permeability (symbol μ) into the empirical equation it becomes MMF = μnI, with the correct dimensions, t^3/s^4 x $s/t = t^2/s^3$.

The error in the dimensions attributed to MMF carries over into the potential gradient, the magnetic field intensity. By definition, this is the magnetic field potential divided by distance, $t^2/s^3 \times 1/s = t^2/s^4$. But the unit in the SI system is the ampere per meter, the dimensions of which are $s/t \times 1/s = 1/t$. In this case, the cgs unit, the oersted, is derived from the dimensionally correct unit of magnetic potential, and therefore has the correct dimensions, t^2/s^4.

The discrepancies in the dimensions of MMF and magnetic field intensity are typical of the confusion that exists in a number of magnetic areas. Much progress has been made toward clarifying these situations in the past few decades, but active, and sometimes acrimonious, controversies still persist with respect to such quantities as magnetic moment and the two vectors usually designated by the letters B and H. In most of these cases, including those specifically mentioned, introduction of the permeability where it is appropriate, or removing it where it is inappropriate, is all that is necessary to clear up the confusion and attain dimensional validity.

Correction of the errors in electric and magnetic theory that have been discussed in the foregoing paragraphs, together with clarification of physical relations in other areas of confusion, enables expressing all electric and magnetic quantities and relations in terms of space and time, thus completing the consolidation of all of the various systems of measurement into one comprehensive and consistent system. An achievement of this kind is, of course, self-verifying, as the possibility that there might be more than one consistent system of dimensional assignments that agree with observations over the entire field of physical activity is negligible.

But straightening out the system of measurement is only a small part of what has been accomplished in this development. More importantly, the positive identification of the space-time dimensions of any physical quantity defines the basic physical nature of that quantity. Consequently, any hypothesis with respect to a physical process in which this quantity participates must agree with the dimensional definition. The effect of this constraint on theory construction is illustrated by the findings with respect to the nature of current electricity that were mentioned earlier. Present-day theory views the electric current as a flow of electric charges. But

the dimensional analysis shows that charge has the dimensions t/s, whereas the moving entity in the current flow has the dimensions of space, s. It follows that the current is not a flow of electric charges.

Furthermore, the identification of the space-time dimensions of the moving entity not only tells us what the current is not, but goes on to reveal just what it is. According to present-day theory, the carriers of the charges, which are identified as electrons, move through the spaces between the atoms. The finding that the moving entities have the dimensions of space makes this kind of a flow pattern impossible. An entity with the dimensions of space cannot move through space, as the relation of space to space is not motion. Such an entity must move through the matter itself, not through the vacant spaces. This explains why the current is confined within the conductor, even if the conductor is bare. If the carriers of the current were able to move forward through vacant spaces between the atoms, they should likewise be able to move laterally through similar spaces, and escape from the conductor. But since the current moves through the matter, the confinement is a necessary consequence.

The electric current is a movement of space through matter, a motion that is equivalent, in all but direction, to movement of matter through space. This is a concept that many individuals will find hard to accept. But it should be realized that the moving entities are not quantities of the space with which we are familiar, extension space, we may call it. There are physical quantities that are dimensionally equivalent to this space of our ordinary experience, and play the same role in physical activity. One of them, capacitance, has already been mentioned in the preceding discussion. The moving entities are quantities of this kind, not quantities of extension space.

Here, then, is the explanation of the fact that the basic quantities and relations of the electric current phenomena are identical with those of the mechanical system. The movement of space through matter is essentially equivalent to the movement of matter through space, and is described by the same mathematical expressions. Additionally, the identification of the electric charge as a motion explains the association between charges and certain current phenomena that has been accepted as evidence in favor of the “moving charge” theory of the electric current. One observation that has had considerable

influence on scientific thought is that an electron moving in open space has the same magnetic properties as an electric current. But we can now see that the observed electron is not merely a charge. It is a particle with an added motion that constitutes the charge. The carrier of the electric current is the same particle without the charge. A charge that is stationary in the reference system has electrostatic properties. An uncharged electron in motion within a conductor has magnetic properties. A charged electron moving in a conductor or in a gravitational field has both magnetic and electrostatic properties. It is the motion of physical entities with the dimensions of space that produces the magnetic effect. Whether or not these entities—electrons or their equivalent—are charged is irrelevant from this standpoint.

Another observed phenomenon that has contributed to the acceptance of the ”moving charge” theory is the emission of charged electrons from current-carrying conductors under certain conditions. The argument in this instance is that if charged electrons come out of a conductor there must have been charged electrons in the conductor. The answer to this is that the kind of motion which constitutes the charge is easily imparted to a particle or atom (as anyone who handles one of the modern synthetic fabrics can testify), and this motion is imparted to the electrons in the process of ejection from the conductor. Since the uncharged particle cannot move through space, the acquisition of a charge is one of the requirements for escape.

In addition to providing these alternative explanations for aspects of the electric current phenomena that are consistent with the “moving charge” theory, the new theory of the current that emerges from the scalar motion study also accounts for a number of features of the current flow that are difficult to reconcile with the conventional theory. But the validity of the new theory does not rest on a summation of its accomplishments. The conclusive point is that the identification of the electric current as a motion of space through matter is confirmed by agreement with the dimensions of the participating entities, dimensions that are verified by every physical relation in which the electric current is involved.

The proof of validity can be carried even farther. It is possible to put the whole development of thought in this and the preceding article to a conclusive test. We have found that mass is a three-dimensional

scalar motion, and that the electric current is a one-dimensional scalar motion through a mass by entities that have the dimensions of space. We have further found that magnetism is a two-dimensional analog of electricity. If these findings are valid, certain consequences necessarily follow that are extremely difficult, perhaps impossible, to explain in any other way. The one-dimensional, oppositely directed, flow of the current through the three-dimensional scalar motion of matter neutralizes a portion of the motion in one of the three dimensions, and should leave an observable two-dimensional (magnetic) residue. Similarly, movement of a two-dimensional (magnetic) entity through a mass, or the equivalent of such a motion, should leave a one-dimensional (electric) residue. Inasmuch as these are direct and specific requirements of the theory outlined in the foregoing paragraphs, and are not called for by any other physical theory, their presence or absence is a definitive test of the validity of the theory.

The observations give us an unequivocal answer. The current flow produces a magnetic effect, and this effect is perpendicular to the direction of the current, just as it must be if it is the residue of a three-dimensional motion that remains after motion in the one dimension of the current flow is neutralized. This perpendicular direction of the magnetic effect of the current is a total mystery to present-day physical science, which has no explanation for either the origin of the effect or its direction. But both the origin and the direction are obvious and necessary consequences of our findings with respect to the nature of mass and the electric current.

There is no independent magnetic particle similar to the carrier of the electric current, and no two-dimensional motion of space through matter analogous to the one-dimensional motion of the current is possible, but the same effect can be produced by mechanical movement of mass through a magnetic field, or an equivalent process. As the theory requires, the one-dimensional residue of such motion is observed to be an electric current. This process is electromagnetic induction. The magnetic effect of the current is electromagnetism.

On first consideration it might seem that the magnitude of the electromagnetic effect is far out of proportion to the amount of gravitational motion that is neutralized by the current. However, this is a result of the large numerical constant, 3×10^{10} in cgs

units (represented by the symbol c), that applies to the space-time ratio s/t where conversion from an n-dimensional quantity to an m-dimensional quantity takes place. An example that, by this time, is familiar to all, is the conversion of mass (t^3/s^3) to energy (t/s). In that process, where the relation is between a three-dimensional quantity and a one-dimensional quantity, the numerical factor is c^2. In the relation between the three-dimensional mass and the two-dimensional magnetic residue the numerical factor is c, less than c^2 but still a very large number.

Thus the theory of the electric current developed in the foregoing discussion passes the test of validity in a definite and positive manner. The results that it requires are in full agreement with two observed physical phenomena of s significant nature that are wholly unexplained in present-day physical thought. Together with the positively established validity of the corresponding system of space-time dimensions, this test provides a verification of the entire theoretical development, a proof that meets the most rigid scientific standards.

CHAPTER 8

The Deductive Development

Ever since the dawn of science, the ultimate objective of the theoreticians in the scientific field has been to devise a general physical theory: one in which all physical phenomena are derived from a single set of premises. As expressed by Richard Schlegel of Michigan State University:

> In a significant sense, the ideal of science is a single set of principles, or perhaps a set of mathematical equations, from which all the vast process and structure of nature could be deduced.

Up to the present time, all of the many efforts along this line have been fruitless. It has not even been possible to derive the relations in one major physical field from general premises; that is, without making assumptions specifically applicable to that particular field and to that field only. But, the development of the Reciprocal System of theory has now produced just the kind of a thing that Dr. Schlegel describes: a set of basic postulates whose necessary consequences are sufficient in themselves to describe a complete, theoretical universe.

More than 90% of the conclusions derived from these postulates are in agreement with concurrent scientific thought and are not contested. Thus, the Reciprocal System is not only a general physical theory; it is a general physical theory that, on the basis of present knowledge, is at least 90% correct. It therefore constitutes a significant advance in scientific understanding, irrespective of the judgment that may ultimately be passed upon the remaining 10% of the conclusions derived from the theory.

Under the circumstances, many individuals are interested in making a critical examination of the development of thought from the fundamental postulates to the various conclusions in order to satisfy themselves that this development is, in fact, purely

deductive. This present work has been designed to facilitate such an examination. In the previous publications which introduced the new theoretical system it was, of course, necessary to devote much of the text to explanation and argument, and even though these works have emphasized the fact that all of the conclusions reached in the theoretical development are derived solely from a determination of the consequences of the postulates, many readers have been unable to follow all of the logical development of the various lines of thought. It is probably that this is due, at least in large part, to a tendency to expect something of a more esoteric nature – some magic formula or all-embracing mathematical expression – rather than the simple "if this, then that" type of deductive development by which the theoretical structure has been constructed. In any event, it has seemed advisable to supplement these previous publications with a presentation which will cover the basic portions of the new system of theory without explanation or argument, and will concentrate entirely on a step-by-step derivation of the pertinent points.

This presentation as it now stands (subject to possible extension later) is essentially no more than a sample; it carries the development of theory forward only a few steps. But even this very modest start toward a determination of the consequences of the postulates already brings us to the point where some of the most important features of the physical universe have been duplicated by the theoretical features that have emerged. Already, in this very early stage of the theoretical development, we find that the universe defined by the theory is expanding (as the observed universe does). It contains radiation, consisting of individual particles (photons) which travel outward at unit speed (the speed of light) in all directions from various points of emission, followed a wave-like path (in full agreement with the properties of radiation as observed.) The speed of light, and of radiation in general, in this universe is constant, irrespective of the reference system (as it is in the observed universe).

The theoretical universe contains matter, consisting of individual atoms (as the observed universe does). This matter is subject to gravitation, which acts instantaneously, without an intervening medium, and in such a manner that it cannot be screened off or modified in any way (just as gravitation does in the observed universe,

although most theorists close their eyes to these facts because they cannot account for them). In this theoretical universe, there are a specific number of different kinds of atoms with different properties; the chemical elements (as in the observed universe). These elements constitute a series, each member of which differs from its predecessor by one unit of a particular kind, and the series is divided into groups and sub-groups with certain group characteristics (all of which is in full agreement with observation). There are additional types of units similar to, but less complex than, the atoms, which have some, but not all, of the properties of the atoms (also in agreement with the observed properties that are currently assumed to exist).

In the light of this demonstration of how the major features of a theoretical counterpart of the observed physical universe – radiation, matter, gravitation, the galactic recession, atomic structure, etc. – can be derived by a relatively simple logical development of the conclusions that are implicit in the postulates of the theory, it should not be difficult to understand how the theoretical universe can be extended into great detail by further application of the same process of following out the logical implications of the postulates and the conclusions previously derived. Furthermore, it is clear, even at this very early stage of the investigation, that this development is capable of resolving some of the most serious issues facing current science.

The manner in which the development of the theoretical structure leads to a unique set of numerical values for each chemical element – a series number, and three rotational displacement values – also shows how the mathematical character of the theoretical universe emerges side by side with the qualitative relationships. Obviously, these sets of numbers are the means by which the elements enter into the mathematical aspects of the many physical relations that appear later in the development, and the simple manner in which they are deduced from the basic premises should serve as an explanation as to why nothing of a more complex mathematical nature than simple arithmetic is needed in the early stages of the inquiry.

The fundamental postulates, together with some comments concerning the interpretation of the language in which they are expressed, are stated in Section A. The statements that follow are sequential; that is, each is a necessary consequence of the statements

that have preceded it, either in the postulates themselves, or in previous deductions from the postulates. The justification for asserting that each specific conclusion is a necessary consequence of something that preceded this may not always be obvious, but the objective of the present work is to identify the specific items entering into the system of deductions leading from the postulates to the various theoretical conclusions, and to show how each fits into the deductive pattern. Everything which might tend to divert attention from this objective, such as explanation or argument, has therefore been omitted. In any case where the continuity of thought may not be clear reference should be made to previous publications describing the theory.

Section A

Conceptual Fundamentals

This theory introduces two new concepts into physical science: the concept of *physical location,* and the concept of *scalar motion.*

The nature of these new concepts can be illustrated by a consideration of the "expansion of the universe" that is postulated in the astronomers' latest theory of the recession of the distant galaxies. As explained by Paul Davies, "The expanding universe is not the motion of the galaxies *through* space… but is the steady expansion of space." Since the galaxies, on this basis, are not moving through space, each galaxy remains in what we will call a physical location in space. This physical location is moving outward in the context of the stationary spatial reference system, carrying the galaxy with it. While only the galactic motion can be observed, all physical locations necessarily participate in the outward motion, irrespective of whether or not they are occupied by galaxies.

Inasmuch as all galaxies, and the physical locations that they occupy, are moving uniformly outward from all others, each is moving outward in all directions. A motion distributed uniformly over all directions has no specific, or inherent, direction; that is, it is scalar. Thus the expansion can be described as a positive scalar motion of all physical locations (represented as outward in the spatial reference system). Our new theory defines a universe of motion in which scalar motion of physical locations is not a

unique phenomenon confined to the expansion recognized by the astronomers, but is the basic form of the motion from which all physical phenomena are derived.

Basic Premises

The basic premises of the theory consist of certain preliminary assumptions, a postulate, and a definition.

A. In order to make science possible, some preliminary assumptions of a philosophical nature must be made. We assume that the universe is rational, that the same physical laws apply throughout the universe, that the results of experiments are reproducible, etc. These assumptions are accepted by scientists as a condition of becoming scientists, and are not usually mentioned in purely scientific discourse.

B. We assume that the generally accepted principles of mathematics, to the extent that they will be used in this development, are valid.

C. We postulate that the universe is composed entirely of one component, motion, existing in three dimensions and in discrete units.

D. We define motion as the relation between two uniformly progressing reciprocal quantities, space and time.

Deductive Development

Each of the following statements is a deduction from the postulate and the preceding statements. The objective of the deductive development is to determine what can exist in the theoretical universe defined by the premises of the theory. In most cases it will be evident that the entity or phenomenon that theoretically *can* exist is identical with one that *does* exist in the actual physical universe, and there are no definite conflicts in any case. To the extent that the outline has been carried, the theoretical universe is thus a correct representation of the observed physical universe.

(1) *Motion,* as defined, is measured in terms of speed, the scalar magnitude of the relation between space and time.

(2) By reason of the postulated reciprocal relation between space and time, each individual *unit of motion* is a relation between one unit of space and one unit of time, a motion at *unit speed.*

(3) We define the *primary motions* as those which can exist independently of the existence of motions of other types.

(4) According to our definition, motion involves a uniform *progression* of both space and time. We define a point, or segment, on the line of the space progression *at a given time* as a physical location in space.

(5) Inasmuch as we postulate that the universe is three-dimensional, we may represent the scalar progression of space by a line in a stationary three-dimensional spatial reference system, measuring the corresponding progression in time by means of a scalar device, *a clock*. In this reference system, a positive motion is represented as *outward* from a reference point, and a negative motion as *inward.* The terms outward and inward will be used in preference to "positive" and "negative" to avoid possible confusion with another use of the latter set of terms.

(6) The initial point of the progression of an individual unit of motion is zero. As the distance between two points cannot be less than zero, it follows that the primary motions are necessarily outward, increasing the distances relative to the initial points.

(7) This progression is scalar. It is simply outward without any inherent direction. Motion outward from the initial point of the progression is therefore outward from all points of reference.

(8) From the foregoing, any two physical locations are progressing outward from each other at unit speed; that is, their separation is increasing at the rate of one unit of space per unit of time.

(9) We define the *natural system of reference as that system in which the primary motions do not cause* any change in the positions of physical locations.

(10) From (8) it follows that the natural system of reference is progressing outward at unit speed

(11) We identify *unit speed* as the *speed of light.*

The various features of the theoretical universe emerge from the deductive development without labels. It is therefore necessary to identify the physical phenomena to which they correspond. The correlation is usually quite evident, as in this instance. In any

event, it is self-verifying, as any error would quickly show up in the subsequent development.

(12) Since the postulate specifies that nothing exists other than discrete units of motion, and the natural reference system is a direct consequence of the existence of the primary units, this reference system is the framework, or background, of the universe of motion, and does not represent any activity *in* that universe. The natural system of reference, as defined, is therefore the physical zero, or datum level, from which all physical activity extend.

(13) We identify the outward progression of the natural reference system relative to the stationary system of reference as the "expansion of the universe" reported by the astronomers.

At this point we have arrived, by deduction from our basic premises, at an explanation of the general background of the physical universe that is essentially in agreement with the astronomers' assumption. (Our derivation leads to a uniform outward speed, rather than a speed that varies with the distance, as produced by the kind of an expansion assumed by the astronomers, but this difference is easily accounted for, because there is a known force, gravitation, that acts against the outward motion, with a magnitude varying as an inverse function of distance.)

The advantage of deriving this explanation of the universal background from a set of general premises, rather than merely assuming its existence, lies in the fact that further deductions can be made from these same premises. Instead of a single process involving the universe as a whole, the explanation that we have just derived from the premises of the theory of the universe of motion identifies the expansion as the result of outward scalar motions of individual physical locations. This opens the way for the existence of other scalar motions of the same physical locations, *independent motions,* as we will call them.

(14) Once the primary units of motion are in existence, units of inward scalar motion can be superimposed on the outward units. The net magnitude of the two motions is zero, and the combination therefore has no physical properties in a spatial

reference system, but it constitutes a base upon which other combinations can be formed.

(15) As stated in our definition, motion is a progression. Thus it is not a succession of jumps, even though it exists only in discrete units. There is progression within the unit, as well as unit by unit, simply because the unit is a unit of motion (progression). The significance of the discrete unit postulate is that discontinuity can occur only between units, not within a unit. But the various stages of the progression within a unit can be *identified*.

(16) The continuity of the progression within the units enables the existence of another type of scalar motion of physical locations. This is a motion in which there is a continuous and uniform change from outward to inward and vice versa; that is, a *simple harmonic motion.* At this stage of the development only continuous processes are possible, but a continuous change from outward to inward and the inverse is just as permanent as a continuous outward or inward motion.

(17) In the two-unit complete cycle of the simple harmonic motion the net change of the spatial position of the physical location is zero. As represented in the spatial reference system, the two-unit combination remains *stationary in the dimension of motion.*

(18) From (10) it follows that the physical location occupied by that motion combination (17) moves outward at the speed of light in a second dimension.

(19) The path of the combined progressions then takes the form of a sine curve.

(20) We identify such scalar motion combinations as *photons.* A system of photons is *electromagnetic radiation.*

This derivation shows why radiation has the properties of a wave as well as those of particles. It is composed of particles (discrete units), but the motion (progression) of these particles is wave-like.

(21) The outward movement of physical locations due to the motion of the natural reference system relative to the stationary spatial system carries with it not only the photons, but also any other physical entities that occupy such locations.

In addition to the photons, there are certain other massless particles that have no known motion-producing mechanism and must therefore remain stationary in the natural system of reference, unless acted upon by some outside agency. There are also objects – very distant galaxies – that do have a motion-producing mechanism (gravitation), but are so far away that the gravitational motion toward our location has been reduced to negligible levels. All of these objects behave exactly as required by the theory; that is, they move outward relative to the spatial reference system at the speed of light.

(22) There is no inherent relation between the time magnitudes involved in the different dimensions of the photon motion. One is the time of the progression of the natural reference system. The other is independent of this progression. Thus the *frequency* of the radiation, the number of cycles per unit of the linear progression, can take any value, subject only to the capability of the process whereby the radiation is produced.

(23) The postulate that the universe is three-dimensional means that three independent magnitudes are required for a complete definition of each of its basic quantities. Thus three dimensions of scalar motion are possible. In order to distinguish these purely mathematical dimensions of motion from the dimensions of *space,* which are geometrical as well as mathematical in the context of a spatial reference system, we will refer to them as *scalar dimensions.*

(24) Only one dimension of motion can be represented in a three-dimensional spatial system of reference. Each motion shown in such a system is represented by a vector, a one-dimensional quantity having both magnitude and direction, and any combinations of such motions can be represented by the vector sum, which is likewise one-dimensional.

(25) A scalar motion has magnitude only, and no inherent spatial direction. It therefore has to be given a direction in order to be represented in a spatial reference system.

(26) To give directions to the members of a system of scalar motions, it is necessary to couple one of the moving locations to the stationary reference system in such a way that it is

represented as motionless. The directions imputed to the other motions of the system are then determined by their relation to this assumed motionless *reference point.*

For example, if we designate our galaxy as A, the direction of the motion of distant galaxy X, as we see it, is AX. But observers in galaxy B see galaxy X as moving in a very different direction BX because they use a different reference point. This contrasts sharply with the directions of the motions of our ordinary experience – vectorial motions – which are the same regardless of the location from which they are being observed. In this vectorial case the direction is the property of the motion.

(27) From (25) and (26), it follows that the factors which determine the direction of a scalar motion are independent of those which determine the magnitude. The direction is a result of the nature and location of the coupling of the motion to the reference system. It may be a *constant* direction, as in the outward travel of the photons of radiation, or it may be a *rotationally distributed* direction, one that is continually changing.

(28) From (27), the translational motion of a photon, instead of being unidirectional as in (18), may be rotationally distributed in the reference system. The motion thus distributed, which we will call a *scalar rotation,* is a linear progression with a constant magnitude but a continually changing direction.

(29) From (23), scalar rotation can take place coincidentally in three dimensions. From (24), however, it can be represented in a spatial reference system only on a one-dimensional basis. The magnitudes of the motions in the three dimensions are additive, and can be represented as a total, but the directions of the different distributions cannot be combined. The representation in the reference system therefore indicates the correct magnitude (speed) of the three-dimensional motion, but shows only the directions applicable to the single dimension of the motion that is parallel to the dimension of the reference system.

(30) In the absence of any specific restrictive factor, rotationally distributed scalar motions are distributed over all spatial directions. The magnitude of such a motion toward a point in any given direction is therefore inversely proportional to the

second power of the intervening distance. This is the origin of the "inverse square law."

(31) Inasmuch as the natural reference system progresses outward at unit speed relative to the spatial reference system, no further increment of outward speed is possible, because of the discrete unit postulate. The net total magnitude of a rotationally distributed linear motion must therefore be inward.

(32) If the scalar motion is less than three-dimensional, the basic photon will move outward as radiation in a vacant dimension and the motion combination will disintegrate. In order to be stable, the rotationally distributed motion must therefore be three-dimensional.

(33) The three-dimensional combination of vibrational and rotationally distributed motions appears in the reference system as an identifiable object moving inward in all directions. We identify such an object as an *atom* or a *sub-atomic particle*. Collectively, the atoms and particles constitute *matter.*

(34) We identify *mass* as a measure of the net magnitude of the rotationally distributed scalar motions of matter. We identify the observable inward-directed effects of this motion as *gravitation.* The magnitude of the gravitational effect is therefore directly proportional to the mass.

(35) The inward gravitational motion of the atoms results in the formation of material aggregates of various sizes. In these aggregates the atomic motions (and masses) are independent and additive.

(36) The outward motion due to the progression of the natural reference system always takes place at unit speed, regardless of the size of the aggregate or the distance that is involved (8). The *net* relative motion of any two gravitating objects with no additional motions is the algebraic sum of the unit outward motion and the inward gravitational motion.

Because of the spherical distribution of the gravitational motion in the reference system, the magnitude of the motion of one unit of matter toward another is inversely proportional to the square of the intervening distance.

(37) At relatively short distances gravitation predominates and the net motion is inward. Since the gravitational motion decreases with distance, while the outward progression remains constant, the opposing motions reach equality at some greater distance, which we will call the gravitational limit. Beyond this distance the net motion is outward, increasing with distance, and approaching unity (the speed of light) at extreme distances.

This theoretical pattern of net speeds is verified observationally by measurements of the Doppler shift in the radiation received from the distant galaxies.

(38) The conventional spatial reference system in conjunction with a clock for measuring time represents a physical situation in which the space component of the progression of the natural reference system is neutralized by gravitation, while the time component progresses at the full normal rate. In this reference system, the space progression, as indicated by the motion of a massless object, appears as a one-dimensional motion through three-dimensional space.

(39) Since we postulate a reciprocal relation between space and time, each of the deductions expressed in the foregoing numbered statements is also valid in the inverse form; that is, with space and time interchanged.

(40) We identify the time component of the progression of the natural reference system as the "flow of time" registered on a clock.

(41) It follows from (39) that motion in time takes place in three dimensions, in the same manner as motion in space. The time component of the progression of the natural reference system (clock time) is a one-dimensional outward motion through a stationary three-dimensional temporal system of reference, in which independent motions at different speeds and different directions also take place.

(42) Motion at unit speed causes unit change of position in both the spatial reference system and the temporal reference system. It is a *motion in time* as well as a motion in space.

(43) When motion takes place in time, the constant progression analogous to clock time is in space, and would be measured

by some kind of a "space clock." But the rates of progression are the same, one unit of space and one unit of time per unit of motion. Thus the measurements relative to the "space clock" are identical with those relative to a clock that registers time, if expressed in the same units.

(44) As noted in (2), the space-time ratio in the units of motion is fixed at unity by the reciprocal postulate. It follows that a reduction of speed – as, for instance, by an increase in the distance between gravitating objects – does not alter the ratio of space to time in the effective motion; it reduces the proportion of the total motion that is effective in increasing the spatial separation of the objects. This effective portion of the motion increases the separation by x units of space per one unit of clock time, where x is a fraction, and because of the fixed relation between space and time in the individual units, also increases the separation in time by x units.

(45) Where only one motion is involved, the x units of time are coincident with the time progression, and do not enter separately into the determination of the speed. But if two objects are both moving, their relative position in space may change at a rate exceeding unity by some quantity x. From (44), the change in the separation in time then also exceeds unity (clock time) by x. The speed is $(1+x)/(1+x)=1$. Thus, if at least one of the two objects is a photon (or other object moving with unit speed), the relative speed is always unity. This agrees with statement (8).

This is the explanation of the observed fact that the speed of light is independent of the reference system.

(46) Where motion at a speed greater than unity (motion in time) takes place under conditions that preclude actual changes of position in time, this motion acts as a modifier of the spatial motion; that is, a motion in *equivalent space.* The spatial equivalent of a temporal magnitude x is $1/x$.

(47) Where scalar motion in space is three-dimensional, the speed in one of the dimensions may be greater than unity. But, as indicated in (29), the effective magnitude of a combination of

motions is determined by the net total of the scalar speeds, and because there are *two* low speed dimensions, the net speed is less than unity. In this case, then, the motion in the high speed dimension acts as a motion in equivalent space and modifies the magnitude of the change of position in space, rather than causing a change of position in time.

(48) We identify the material atoms with scalar rotation in equivalent space as the atoms of the *electronegative elements.*

(49) We also encounter motion in equivalent space within the units of space. Here no modification of the normal progression of space can take place (because of the discrete unit postulate), but motion can take place in time. Inasmuch as this motion within the spatial unit does not alter the position in time of the unit as a whole, the changes within the unit that result from the motion are observed in equivalent space rather than in actual time.

(50) The existence of a spatial unit, where motion has properties quite different from those prevailing in the region outside the unit, explains the discontinuity in physical properties at very short distances that has led to the development of the quantum theory.

(51) The progression of the natural reference system relative to the spatial system of reference is always outward, but, as indicated in (10), the natural datum level, or physical zero, is at unity, rather than at the mathematical zero. Within a unit of space, outward from unity is toward zero. It follows that the progression within the unit, as seen in the spatial reference system, is inward.

(52) From (31), the gravitational motion is inward. This direction, too, is inward relative to the natural datum, unity. Within a unit of space, it is therefore outward in the spatial reference system.

(53) No stable equilibrium between the atoms or aggregates of matter is possible at separations greater than one unit of space. The inward and outward motions are equal at the gravitational limit, but this equilibrium is unstable, as the change in separation due to any unbalance between the opposing motions increases the unbalance. Within a unit of space, where the directions of the basic motions as seen

in the spatial reference system, are reversed; the effect of a change in separation between atoms due to an unbalance of the opposing motions reduces the unbalance, and eventually results in the establishment of a stable equilibrium.

(54) The positional equilibrium in equivalent space that is established within a unit of space accounts for the existence of the crystalline state of matter.

Section B

In the first section of this outline, the general characteristics of the motion of which the universe is constructed, together with additional information about the various forms and manifestations of that motion, were deduced from the postulates of the theory. With the benefit of this information we are now in a position to develop the details of the individual phenomena in the various physical fields. We will begin by identifying the possible combinations of scalar rotations (atoms and sub-atomic particles) and their individual characteristics, including the properties that are represented in the periodic table of the elements. As in Section A, each statement is a deduction from the postulates of the theory or from one or more of the numbered statements earlier in the outline.

(55) As noted in (12), the primary motions are the framework, or background, of the universe of motion, and do not constitute any physical activity in that universe. Physical activity – that is, meaningful change – in the physical universe results from motions superimposed on the primary motions. We will now want to examine the general considerations involved in such *combinations* of motions. First we note that there are no restrictions on the combination of motions of the same kind in different dimensions. For instance, rotations in different scalar dimensions can combine by rotating around the same central point.

(56) The normal progression, both of the natural reference system and of the added motions, is a continuous succession (rather than a combination) of units of the same kind. As soon as one unit of the progression ends, another one begins. But the

units in a *succession* do not necessarily have to be identical. For example, the two-unit cycle of simple harmonic motion has the same initial and final points as a two-unit segment of unidirectional linear motion, and therefore fits into the linear progression. We may generalize this situation and say that *compatible* units of a different kind of motion can replace units in the normal progression.

(57) It follows from (44) and (56) that compatible units of motion added in a dimension of an existing motion will merge with this previously existing motion, merely altering its magnitude. Formation of a *compound motion,* a combination that retains the distinction between its components, therefore requires the addition of an incompatible motion.

(58) Except where outside forces intervene, the added motion must oppose the original in order to achieve stability. Otherwise there is nothing to hold the components together. The opposition reduces the net total magnitude of the motion, and since lower numbers are more probable than higher numbers, this makes the combination more probable than independent existence of the components.

(59) A numerical constraint on the combinations is imposed by the discrete unit postulate. Addition of two inward units of motion to the unit outward progression of the natural reference system produces one net inward unit, the limiting value. The maximum linear addition to a motion combination is thus two units.

(60) Where the motion is n-dimensional, the maximum is two units in each dimension, a total of 2^n units.

(61) Scalar motion is measured in terms of *speed* (or inverse speed). As we have seen, however, the natural datum level is at unity, not at zero. The natural speed magnitudes are therefore the deviations from unity. A deviation downward from unity, 1/1 to 1/*n,* has the same natural magnitude, *n-1* units, as a deviation upward from 1/1 to *n*/1. In dealing with the basic scalar motions we will therefore use the deviations rather than the speeds measured from zero. We will call these deviations *"speed displacements,"* abbreviated to "displacements" where the meaning is clear.

(62) Where quantities are reciprocally related, the choice as to which should be called "positive" is purely arbitrary. It will, however, be convenient to refer to the phenomena of our ordinary experience as positive. Since the speeds in our local environment are below unity, we will call a decrease in speed from 1/*m* to 1/*n* a *positive* displacement of *n-m* units, and an increase in speed from *m*/1 to *n*/1 a negative displacement of *n-m* units.

(63) The photon, as defined in (20), is a vibrating unit that moves outward translationally at the speed of light. As noted in (22) the frequency of the vibration is limited only by the capacity of the production process. The atom, defined in (33) is likewise a vibrating unit with an added linear (scalar) motion, but in this case the linear motion is rotationally distributed over all directions, and the rotational character of the added motion imposes some restrictions on the numerical magnitudes.

(64) A one-dimensional scalar rotation (28) of the linear vibrational unit generates a two-dimensional figure, a disk. A scalar rotation of the disk around another axis generates a three-dimensional figure, a sphere. This exhausts the available dimensions. The basic scalar rotation of the atom is therefore two-dimensional.

(65) While no further rotation of the same kind (inward) is possible, the entire combination of motions can be given an *outward* scalar rotation around the third axis. This conforms to the requirements of (57)–it is a one-dimensional addition to a two-dimensional motion–and those of (58)–it is an outward motion added to an inward motion.

(66) The vibrational speed displacement of the basic photon may be either positive (less than unity) or negative (greater than unity). For the present, we will consider only those combinations in which the basic vibrational displacement is negative. We will call this system of combinations the *material* system. The system based on the positive photon speed will be called the *cosmic* system.

(67) From (58) we find that where the vibrational displacement is negative the net total rotational displacement must be positive.

(68) Where a one-unit positive rotational displacement is applied to a one-unit negative vibration, the net total speed displacement

(a scalar quantity) is *zero.* This combination of motions has no effective deviation from unit speed (the physical datum) and therefore has no observed physical properties. We will call it the *rotational base* of the material system. A similar combination with positive vibration and negative rotation is the rotational base of the cosmic system.

(69) For convenience, we will represent the different motion combinations of this type of sets of numbers representing the speed displacements in the three scalar dimensions. We will specify only the *effective* magnitudes of the displacements and we will use the letters M and C to indicate whether the combination belongs to the material or the cosmic system. The displacement magnitudes will be expressed in the form M a-b-c, where a and b are the effective displacements of the two-dimensional rotation, which we will call the *magnetic rotation,* and c is the effective displacement of the one-dimensional, or *electric rotation.* Negative (spatial) displacements will be enclosed in parentheses. On this basis, the material rotational base is M 0-0-0, and the cosmic rotational base is C 0-0-0.

(70) To the material rotational base we may add a unit of positive electric rotational displacement (that is, one unit of effective one-dimensional scalar rotation), producing M 0-0-1, which we identify as the *positron.* Or we may add a unit of negative electric displacement, producing M 0-0-(1), which we identify as the *electron.* These are the first members of a series of combinations that we identify as the *sub-atomic particles* of the material system.

(71) Addition of a magnetic (two-dimensional) displacement unit to the material rotational base produces M ½-½-0. There are no half units, but a magnetic unit occupies both dimensions, and we therefore credit half to each. We identify this combination as the *muon neutrino.*

(72) At the unit level, the magnetic and electric displacement units are numerically equal; that is, 12 = 1. Addition of a unit of negative electric displacement to the muon neutrino therefore

produces a combination with a net total rotational displacement of zero. We identify this combination, M ½-½-(1), as the *electron neutrino* (hereinafter referred to simply as the *neutrino*).

(73) Geometrical considerations indicate that two photons – in different scalar dimensions – can rotate around the same central point without interference as long as the rotational speeds are the same, thus forming a double structure. Any rotational combination with two or more net units of rotational displacement can take the double structure.

(74) This introduces a new situation: the existence of competing structures. The aim of our development of the consequences of the postulates of the theory of the universe of motion is to determine what *can* exist in that theoretical universe. Thus far we have been able to identify an existing feature of the observed physical universe corresponding to each of the entities and phenomena that we have found that can exist in the theoretical universe. From now on we will have to consider the possibility that the existence of certain structures may preclude the existence of competing structures. The result of the competition in each case is a matter of relative probability. Where the probabilities are nearly equal, the structures may coexist. Otherwise, the structure that is most probable (in a given set of circumstances), is the only one that exists under those circumstances, other than momentarily.

(75) The double rotational structure is more compact, and therefore more resistant to disruption than the equivalent single structures. This gives it a sufficient margin of probability to preclude the existence of any significant quantity of the competing single structures (unless external forces intervene).

(76) We identify the double rotational combinations as *atoms.*

(77) The combination ½-½-1 has a total net rotational displacement of 2 and is excluded by (75). The two-unit magnetic structure M 1-1-0, and its positive derivative M 1-1-1, which have net displacements of 2 and 3 respectively, are likewise excluded for the same reason. But the negative derivative M 1-1-(1) can exist as a particle, since its net displacement is only one unit. We identify it as the *proton.*

(78) A double rotating system with only one net unit of displacement can be formed by a combination of a rotation of the proton type, M 1-1-(1) and a rotation of the neutrino type, M ½-½-(1). We identify this combination, M 1½-1½-(2), as the mass 1 isotope of *hydrogen.* Since the second rotation has a net displacement of zero, the probability difference between this double structure and the equivalent single structure, the proton, is small. These structures therefore coexist under appropriate conditions.

(79) If the cosmic neutrino type of rotation, C (½)-(½)-1, is substituted for the material neutrino type of rotation in this double structure, the combination has net total displacements of M ½-½-0. We identify it as the *neutron.*

(80) Because of some significant differences between atoms and sub-atomic particles, we will use a different system of notation in representing the atomic combinations. This notation will show the *total* speed displacement in each dimension (including the initial non-effective unit), will use a double unit, and will omit the letter symbols M and C, which are unnecessary when the initial unit is included.

(81) To convert the rotational displacement of the mass 1 hydrogen atom from the sub-atomic notation, M 1½-1½-(2), to the atomic notation, we divide by 2, obtaining 1-½-(1), and then add the initial unit, the result being 1½-1-(1). The net effective displacement, in terms of the double unit is ½.

(82) An additional single unit of displacement brings the total to 2-1-(1). We identify this combination as the mass 2 isotope of hydrogen. This is the first of the complete two-rotation combinations (those with effective rotational displacement in both rotations). It is therefore given the *atomic number* 1.

(83) One positive displacement unit (atomic basis) added to mass 2 hydrogen, 2-1-(1), neutralizes the negative electric rotation, and produces 2-1-0. We identify this combination as *helium, atomic number 2.*

(84) Successive additions of units of positive electric displacement, or the equivalent, to the helium atom, produce the other members of a series of atomic combinations, the series of *chemical elements.*

(85) Inasmuch as the two-dimensional (magnetic) rotation is the basic rotation of the atom, as indicated in (64), the magnetic rotation takes precedence over the electric rotation where both are possible. It follows that some of the additions to the atomic series involve magnetic displacement in lieu of electric displacement. If we let *n* represent the number of double magnetic units of displacement (units of atomic number), the corresponding number of single magnetic units is *2n.* When acting jointly in a motion combination, x magnetic units are equivalent to x^2 one-dimensional (electric) units. The *2n* single magnetic units are therefore equivalent to $4n^2$ single electric units. Dividing by 2 to convert the double units of the atomic system, we find that n magnetic displacement units in an atom are equivalent to $2n^2$ electric displacement units.

(86) Successive additions of magnetic displacement go alternately to the two magnetic dimensions, since small numbers are more probable than larger numbers. One magnetic unit added to helium, 2-1-0, produces 2-2-0, which we identify as *neon.*

(87) Helium already has one effective magnetic displacement unit in each magnetic dimension. Thus the increase from 2-2-0 involves a second unit in one of the dimensions. From (85), this second magnetic unit is equivalent to $2 \times 2^2 = 8$ electric units. It should be noted that this is the electric equivalent of the *second* unit, not the sum of the two units. The reason is that the progression in the region inside unit space takes place in time only, and the succession of values is 1/1, 1/2, 1/3,… 1/*n.* The number of time units involved is 1, 2, 3,… *n.* Thus the value 2 applies to the second unit only, not to the total of the first two units.

(88) The first four additions of electric displacement units to helium produce the following series of elements:

Number	Displacements	Element
3	2-1-1	Lithium
4	2-1-2	Beryllium
5	2-1-3	Boron
6	2-1-4	Carbon

(89) As long as the magnetic displacement – the major component of the atomic rotation – is positive, the electric displacement – the minor component – can be negative without violating the requirement (67) that the net total rotational displacement of a material atom must be positive. Carbon can therefore exist with the alternate displacements of 2-2-(4). Here the neon type magnetic rotation with net displacement 10 is combined with 4 negative electric displacement units, for a net positive total of 6, the same as the net displacement of the 2-1-4 combination. The probability difference between these two combinations is small, and both are found observationally. Beyond carbon the probabilities favor the smaller negative electric displacement. The normal forms of the next three elements are therefore:

Number	Displacements	Element
7	2-2-(3)	Nitrogen
8	2-2-(2)	Oxygen
9	2-2-(1)	Fluorine

(90) Another group of eight elements follows, bringing the second magnetic dimension up to two effective displacement units at argon, 3-2-0. A further one-unit increase raises the effective displacement level to 3 units in one of the magnetic dimensions. The third magnetic unit is equivalent to $2 \times 3^2 = 18$ electric units. Two 18-unit groups of elements therefore follow, increasing the displacements first to 3-3-0 (krypton, element 36) and then to 4-3-0 (xenon, element 54). Finally, there are two groups of $2 \times 4^2 = 32$ elements each. The first of these carries the series of 4-4-0 (radon, element 86). The second would reach 5-4-0 (element 118), but here another factor intervenes.

(91) From (60), the maximum three-dimensional scalar rotation has a magnitude of eight units. The significance of this is that at a speed displacement of eight net units, the rotationally distributed progression reaches the same scalar location, the end of the spatial unit, that a linear progression reaches in the same time interval. The next unit of the progression then begins without any limitation on the nature of the coupling

to the reference system. In the absence of such a limitation, the motion takes the most probable form, a unidirectional linear progression. This means that at element 118, where the rotational displacements are 5-4-0, and there are a total of eight effective magnetic displacement units (four in each dimension), the rotational combination of motions disintegrates and reverts to the linear basis. The series of chemical elements therefore terminates at element 117.

(92) Because the succession of speed displacements follows the definite pattern outlined in (84) to (91), each element can be characterized by a unique set of numbers (subject to some modification under special circumstances). These are the values that enter into the various equations which determine the magnitudes of the different properties of the elements and their combinations.

(93) Each successive element in the atomic series adds one double unit of positive three-dimensional rotational speed displacement to the combination of motions (the atom). In (34), three-dimensional speed displacement, positive in the material system, was identified as mass. The atomic mass is expressed in terms of *atomic weight*, the unit of which is half the rotational mass corresponding to the atomic number. The *rotational mass* of an atom of atomic number n is thus *2n* atomic weight units.

(94) When physical quantities are resolved into component quantities of a fundamental nature, these component quantities are called "dimensions." Since we postulate that the physical universe is composed entirely of units of motion, a relation between space and time, the dimensions of all physical quantities (in this sense of the term) can be expressed in terms of space and time only. From (34), the three-dimensional gravitational motion of the atoms of matter has the dimensions s^3/t^3, where s and t are space and time, respectively.

(95) In order to change the spatial position of an atom, or an aggregate of atoms, an outward motion must be applied against the inward scalar motion of the atom. That inherent

inward motion then acts as a resistance to the applied outward motion. In this capacity as a resistance, or *inertia,* the mass acts as the inverse of a three-dimensional speed, with the dimensions t^3/s^3. In practice, gravitation is measured in terms of force, a derivative of inertia, rather than in terms of speed. Both the gravitational and the inertial relations are therefore expressed in terms of the t^3/s^3 magnitudes.

This explains why measurements of the "gravitational mass" and the "inertial mass" arrive at the same result.

(96) Having established the space-time dimensions of mass, we can now define the dimensions of the other physical quantities of the mechanical system. The product of mass and speed, *momentum,* is $t^3/s^3 \times s/t = t^2/s^2$. The product of mass and the second power of speed is *energy,* is $t^3/s^3 \times s^2/t^2 = t/s$. *Acceleration,* the time rate of change of speed, is $s/t \times 1/t = s/t^2$. *Force,* the product of mass and acceleration, is $t^3/s^3 \times s/t^2 = t/s^2$.

(97) Physical phenomena with the same dimensions have the same general status in physical interactions and are interchangeable. For example, all phenomena with the dimensions t/s are equivalent to energy, and can be converted to kinetic energy by appropriate processes.

Section C

In this section, we examine the application of the general physical principles developed in Section A to the basic phenomena of another physical field. The field selected for examination in Section B was chosen to show how the quantitative relations emerge easily and naturally from the mainly qualitative general principles and relations. Now in this third section, we demonstrate the ability of the theory of the universe of motion to clarify the theoretical relations in a field that has heretofore been subject to much confusion. As in the preceding sections, each statement is a deduction from the postulates of the theory or one or more of the numbered statements earlier in the outline.

(98) The only difference between the effective component of the electron, M 0-0-(1), and the rotational base, M 0-0-0 (69),

is one unit of rotational space displacement. It is therefore a rotational combination with the dimensions of space.

The term "electron," as used in this outline refers to the particle defined in (70). Similar particles carrying charges will be identified as "charged electrons."

(99) As noted in (97), different physical phenomena with the same space-time dimensions have the same status in physical interactions. From the general physical standpoint, the electron is therefore equivalent to a unit of what we may call extension space, the "space" of our ordinary experience.

The idea of the equivalent of ordinary space is new to science and may be conceptually difficult for some scientists, but it is the same kind of a concept as the idea of the equivalent of ordinary kinetic energy that we have all become accustomed to. For example, if we wish to put a rocket into orbit, what we have to do is to accelerate it to a certain speed; that is, give it a certain amount of kinetic energy. But, in addition, we must provide enough fuel energy to compensate for the difference in the energy of position – potential energy – and lift the rocket against the earth's gravity. This potential energy is not "kinetic energy," but it is "energy," and in relations involving energy in general it is the *equivalent* of kinetic energy. Similarly, electron space is not "extension space," but it is "space," and in relations involving space in general it is the equivalent of extension space.

(100) From (67), the net speed displacement of the atoms of ordinary matter is positive; that is, in terms of effective units there is an excess of time over space. The electron can therefore move through matter, as the relation of space (electrons) to time (matter) constitutes motion, according to the postulates of the theory of the universe of motion. It cannot move through space, relative to the natural reference system, as the relation of space (electrons) to extension space does not constitute motion.

(101) We identify the movement of electrons through matter as *current electricity.* It should be noted that the current moves through the matter, *not* through the spaces between the atoms, as has been assumed.

(102) The movement of space (electrons) through matter is identical, except in scalar direction, with the movement of matter through extension space. Thus quantities involved in these motions, and the relations between them, are thus the same in both cases. We may characterize the relations involved in the movement of space through matter as the mechanical aspects of electricity.

(103) Since the scalar direction of gravitation (a movement of matter through space) is inward (34), it follows from (102) that the scalar direction of current electricity is outward.

(104) The electrons (effective dimensions s) are units of electric quantity, *q*. The rate at which the electrons move through matter (quantity per unit time) is the electric current, *I*, with dimensions s/t, equivalent to those of *speed*. Electrical force, or voltage, *V*, has the general force dimensions t/s^2. The product of voltage and current is power, *P*, with dimensions $t/s^2 \times s/t = 1/s$. The product of power and time is electrical energy, or work, *W*, dimensions $1/s \times t = t/s$. The mass taking part in the current flow is not a constant quantity, but depends on the duration of the current. The mass per unit time, dimensions $t^3/s^3 \times 1/t = t^2/s^3$, is therefore a significant quantity in current electricity. We identify it as resistance, *R*.

(105) To demonstrate the identity of the electric current relations (motion of space through matter) with those of the mechanical system (motion of matter through space), we may compare the energy equations. Kinetic energy is $\frac{1}{2}mv^2$, space-time dimensions $t^3/s^3 \times s^2/t^2 = t/s$. Electrical energy is $Rt\,I^2$, dimensions $t^2/s^3 \times t \times s^2/t^2 = t/s$. Another mechanical expression for energy is force times distance, $F\,d = t/s^2 \times s = t/s$. The analogous electrical expression is voltage times electrical quantity, $V\,q = t/s^2 \times s = t/s$. In both cases the equations are identical, except for the terminology.

(106) Since they are phenomena of the same kind, the flow of electrons through a conductor is analogous to the flow of gas molecules through a pipeline. A constant force (voltage) differential causes a steady flow of current.

This agrees with observation. Existing theory ascribes the flow to a difference in electrostatic potential, which it does not distinguish from voltage. But such a potential difference applied to the charged electron which is assumed to be the moving entity would result in an accelerated motion. Present-day science has no explanation for this contradiction.

(107) From (33), the scalar motion that constitutes the atom of matter is three-dimensional and inward. The one-dimensional outward movement of electrons (units of space) through matter, or through a gravitational field, therefore neutralizes a portion of the gravitational motion and leaves a scalar motion remnant in two dimensions. The physical effects of this residual motion are known as *electromagnetism*. As would be expected, they are similar to those of gravitation, except for the differences introduced by the two-dimensionality.

(108) The residual motion in two dimensions is perpendicular to the dimension of the motion that is neutralized; that is, perpendicular to the electric current.

This provides the explanation of the unique direction of electromagnetism that has heretofore been an unexplained anomaly.

(109) As the residue of the inward gravitational motion, the electromagnetic motion is necessarily inward. However, the orientation of the scalar direction "inward" with respect to the spatial reference system is reversed when the direction of the current is reversed.

Conductors carrying current in the same direction move toward each other, while conductors carrying currents in opposite directions move away from each other.

(110) There is no two-dimensional analog of the electric current because the material system contains no negative magnetic particle. But the equivalent of a magnetic current, a two-dimensional motion through matter, can be produced by various means, such as mechanical movement of a conductor in a magnetic field. This two-dimensional motion neutralizes a portion of the three-dimensional motion of the matter,

and leaves a one-dimensional residue. If a conductor is appropriately located, this residue manifests itself as an electric current. The process of producing a current by this means is known as *electromagnetic induction.*

(111) As noted in (1), motion in general is measured in terms of speed. When represented in a spatial reference system, the motion acquires a direction, and speed becomes *velocity.* The introduction of directions does not affect the dimensional relations. All of the previous dimensional conclusions stated in terms of speed are equally valid in terms of velocity.

(112) From (111) and (96), the product of mass and velocity, *momentum,* has the dimensions t^2/s^2. This quantity was formerly called "quantity of motion," an expression which more clearly indicates its nature. It is actually a measure of the total motion of the mass, which consists of n mass units, each having the quantity of motion measured by the velocity. The time rate of change of velocity is acceleration. The time rate of change of the product of mass and velocity, the "quantity of motion," is *force.* Thus force is, by definition, the same kind of a property of motion as acceleration. We could appropriately call it "quantity of acceleration."

(113) Since force is *by definition* (112), a *property* of motion, it follows that a *force cannot be autonomous.* The so-called "fundamental forces of nature" are necessarily properties of fundamental motions.

(114) The same considerations apply to the electrostatic force, which, from (112), must also be the force aspect of an electric motion. For an understanding of this motion we return to the question as to the types of scalar motion that can exist in the theoretical universe. Thus far we have encountered three general types:

1) Unidirectional linear motion;
2) Vibrational (simple harmonic) motion, which is linear motion with a continuous change from inward to outward, and vice versa;
3) Scalar rotation, which is a uniform rotationally distributed scalar motion.

Obviously, there is a fourth possibility, a *scalar rotational vibration;* that is, a rotationally distributed scalar motion with a continuous change from inward to outward and vice versa, a rotational simple harmonic motion.

(115) An independent rotational vibration cannot exist, as there would be nothing to confine the progression to the rotational path, and it would revert to the more probable linear status. But a unit of rotational vibration can be *combined* with a unit of rotation. The inward phase of the rotational vibration is coincident with the corresponding rotation, and has no physical effect. The outward phase is an effective rotationally distributed scalar motion opposing the atomic rotation in the dimension, or dimensions, of the rotational vibration. It thus conforms to the requirement for stability, as expressed in (58).

(116) From (57), the rotational vibration must not be of the same general nature as the rotation to which it is applied. The effect of this restriction is to bar three-dimensional rotational vibration. The added rotational vibrations may be either one-dimensional or two-dimensional.

(117) We identify a rotational vibration as a *charge*, and a one-dimensional charge as an *electric charge.*

Inability to identify any motion connected with the electric charge is one of the reasons why the theorists have accepted the force exerted by the charge as fundamental, even though this conflicts with the definition of force, as noted in (112). The explanation, as indicated above, is that *the charge itself is the motion.*

(118) From (115), the charge must have a carrier, an atom or particle. Independent charges do not exist.

(119) From (117), the space-time dimensions of the electric charge are t/s; that is, the charge is dimensionally equivalent (97) to energy.

The equivalence is demonstrated by the fact that charge and kinetic energy are interconvertible.

(120) Electric charges may be either positive or negative, but the total displacement is smaller, and therefore more probable, if the displacement of the charge is opposite to that of the

rotation. Consequently, a positive rotation takes a negative charge, and vice versa. But in current practice the rotational combinations are designated as positive (or electropositive) if they normally take positive electric charges, and negative (or electronegative) if they normally take negative electric charges. It is not feasible to try to change this firmly established practice, so the usual terminology will be applied in the statements that follow, with the understanding that the significance appertaining to the terms "positive" and "negative" elsewhere in this outline is reversed in application to electric charge.

(121) From (26), we find that in order to represent a scalar motion in a fixed spatial reference system it is necessary to identify a *reference point.*

(122) The motion of a positive charge (a high speed rotational vibration) is outward from a negative reference point toward more positive values, including the positive reference points. That of a negative charge (a low speed rotational vibration) is outward from a positive reference point toward more negative values, including the negative reference points.

The reference system cannot distinguish between positive and negative reference points. This is another of the deficiencies of the conventional spatial reference system.

(123) From (122), two positive charges move outward from the same reference point, and therefore outward from each other (7). Two negative charges do likewise, but a positive charge moves outward from a negative reference point toward all positive reference points, including the reference point of the negative charge, and therefore *toward* the negative charge. Thus, like charges repel each other, while unlike charges attract.

(124) These scalar directions of the electrostatic forces are opposite to those of the corresponding electromagnetic forces (109); that is, like electric charges repel, whereas like currents (those moving in the same vectorial direction) attract.

This agrees with the theoretical scalar directions of these two types of motion, which are opposite. The electromagnetic

motion (109) is inward, while the electrostatic motion (115) is outward.

(125) An electric charge can be applied either against the electric rotation or against one dimension of the magnetic rotation. All atoms and sub-atomic particles of the material system, except the electron, have at least one effective positive displacement unit. With the one exception, all of them can therefore take positive charges. Negative charges are confined to the sub-atomic particles with negative electric displacement, and to the electronegative elements with electric displacement of 4 or less. Those with higher displacements are usually excluded by the greater probability of positive charges based on the lower magnetic displacements.

(126) Application of an electric charge to the electron neutralizes the net negative displacement of the particle.22 As a neutral particle, containing both positive and negative components, the charged electron is able to move either through matter (predominantly time) or through space. The charged electrons move through matter in the same manner as their uncharged counterparts; that is, they move freely through good conductors, less easily through poor conductors, and are blocked or impeded by insulators. We identify the various phenomena involved in the production and movement of these charged electrons as *static electricity.*

(127) Electric charges may also be applied to atoms (existing individually or in combinations), which are then known as *ions.* As noted in (115), each unit of rotational vibration combines with a unit of rotation. The maximum degree of ionization (number of applied charges) is therefore equal to the net rotational displacement. Negative ionization is confined to the most electronegative members of each rotational group, and is limited to the magnitude of the negative electric displacement of each atom. Positive ionization can take place up to the number of net positive rotational displacement units in the atom (the atomic number). An atom in this limiting condition is said to be *completely ionized.*

(128) A charge (rotational vibration) may be two-dimensional, rather than one-dimensional. In that case, it constitutes a *magnetic charge*. Material objects carrying magnetic charges are known as *magnets.* Where the charge persists for a substantial period of time, the term *permanent magnet* is applied.

(129) Because of the orientation effect noted in (109) which applies to all two-dimensional scalar motion – the scalar direction (inward or outward) of the motion that constitutes the magnetic charge reverses with the direction relative to the reference system. Thus, a magnetic charge exerts an attractive force on a similar charge in one vectorial direction, and a repulsive force on one that is located in the diametrically opposite direction.

(130) The force exerted by a magnet is the net total of the magnetic forces of the individual magnetic charges on the atoms. Each magnet therefore has two centers or *poles* at which the net magnetic forces in the opposite directions are at a maximum.

(131) From (130) it can be seen that while a magnetically charged object has only two poles, if that object is separated into parts, each part also has two poles.

(132) The existence of magnetic monopoles is excluded by (131).

Present-day physical theory requires the existence of positive and negative monopoles analogous to positive and negative charges, and continuing attempts are being made to find such phenomena, without success.

(133) As in the case of positive and negative electric charges, and for the same reasons (123), like poles repel each other, while unlike poles attract.

(134) Inasmuch as the magnetic charge is the two-dimensional analog of the one-dimensional electric charge, it has the space-time dimensions t^2/s^2. The dimensions of the quantities involved in *magnetostatics,* the phenomena of magnetic charges, are therefore related to those of the corresponding electrostatic quantities (where analogous quantities exist) by the factor t/s.

(135) This relation (134) enables us to make a *positive* identification of the dimensions of the magnetostatic quantities. Magnetic

charge, t^2/s^2, is not recognized under that name in current scientific thought, but an equivalent quantity, *magnetic flux,* which has these dimensions, is utilized in many of the same applications. The unit of magnetic flux in the SI system is the Weber, which is equal to a volt-second, dimensions $t/s^2 \times t = t^2/s^2$. The analog of electric potential, t/s^2, is *magnetic potential,* also called *vector potential,* to distinguish it from some other quantities which have, or are thought to have, the characteristics of potential. The dimensions of magnetic potential are $t/s^2 \times t/s = t^2/s^3$. The SI unit is the Weber per meter, $t^2/s^2 \times 1/s = t^2/s^3$. Corresponding to electric field intensity, t/s^3, is *magnetic field intensity*, $t/s^3 \times t/s = t^2/s^4$. This quantity is defined as magnetic flux per unit area, on which basis the space-time dimensions are $t^2/s^2 \times 1/s = t^2/s^4$. Thus, all of these magnetic quantities have dimensions equal to the dimensions of the corresponding electric quantities multiplied by the factor t/s, as required by the theory.

(136) In a number of other cases, the dimensions currently assigned to the magnetic quantities do not agree with those derived from theory in the foregoing manner. Here, the currently accepted dimensional assignments have been based on empirical observations, and the accurate dimensional analysis that is now possible shows that the observations have been improperly interpreted.

(137) For example, observations show that *magnetomotive force* (MMF) is related to the current, *I,* by the expression MMF = *nI,* where n is the number of turns in a coil. Since n is dimensionless, this relation indicates that the dimensions of MMF are the same as those of the electric current. The unit of MMF is therefore taken as the ampere, dimensions s/t. But MMF has the characteristics of a force (as the name implies), and the dimensions should be those of magnetic potential, t2/s^3. The dimensional study shows that the discrepancy is due to the fact that the analog of electric resistance, the permeability, dimensions $t/s \times t^2/s^3 = t^3/s^4$, enters into the physical relation and this relation is actually MMF = *mnI,* where *m* is the *permeability.* The presence of this quantity is not detected by

the usual mathematical analysis, as it takes the unit value in most magnetic applications, and has no numerical effect.

(138) When the magnetic relations are corrected by introducing the permeability, and making the necessary adjustments to remove some other errors, the entire system of magnetic quantities is brought into agreement with the mechanical and electrical dimensions. This completes the identification of a comprehensive and entirely consistent system of dimensional relations covering the full range of physical phenomena.

The demonstrated ability to express the dimensions of all physical quantities in terms of space and time is not only a powerful tool for analyzing physical relations, but also provides an impressive confirmation of the validity of the postulate that the physical universe is composed entirely of these two components.

(139) The most serious error about conventional electric and magnetic theory revealed by the dimensional analysis, is the lack of distinction between *electric quantity* and *electric charge* that has resulted from the assumption that the electric current is a movement of charges. In present-day practice, both charge and quantity are measured in the same units—coulombs in the SI system. But the interconvertibility of electric charge and kinetic energy (97) definitely shows that charge has the energy dimensions, t/s, while the relations cited in (104) demonstrate just as definitely that electric quantity has the dimensions of space, s, as required by the theory of the universe of motion.

(140) From (139) it follows that there are two distinct kinds of electric and magnetic phenomena: (1) the *electric current* and *electromagnetism,* in which the basic entities are units of electric quantity (dimension s), acted upon by forces due to voltage differences, and (2) the phenomena classed as *electrostatic* and *electromagnetic*, the basic units of which are units of electric charge (dimension t/s) and magnetic charge (dimension t^2/s^2), acted upon by forces due to potential differences.

(141) Electric charges moving through matter or through a gravitational field are carried by particles or atomic constituents

with rotational characteristics similar to those of the particles. The movement of these carriers produces electromagnetic effects, while the charges that are being carried produce electrostatic effects.

(142) From (141), an aggregate of charged electrons has both a voltage and a potential.

This explains the operation of such devices as the Van de Graaf generator, in which charged electrons at a low potential flow into a storage sphere in which the potential may be very high. A flow in this direction would be impossible if, as asserted by present-day theory, only one force, electric potential, is operative. But the foregoing development of theory shows, that there are actually two forces involved and the direction of flow depends on the voltage differential, not on the potential difference. The voltage in the storage sphere is determined by the electron concentration, and may be low, even when the potential is in the million volt range.

Section D

In the preceding Sections, we have presented a step-by-step deduction from the fundamental Postulates of the *Reciprocal System* of theory of the phenomena of the physical universe pertaining to the atomic domain. In this section, we carry forward these deductions to the astronomical field and show how phenomena, some of which have not had proper explanations in conventional theory, emerge logically from these deductions. This section, therefore, serves to demonstrate the *general* nature of the Reciprocal System of theory.

(143) At this point, we will need to take into account the concentration of energy in the vicinity of matter subject to electrical ionization, and some consideration of the nature of this concentration will be required. As long as atoms or aggregates are free to move unidirectionally, there can be no significant spatial (volumetric) concentration of their kinetic energy. Such a concentration is accomplished by *containment.* Initially, the spatially restricted motion, *thermal motion,* as we will call it, is contained within the individual units of space.

When the energy level is high enough to permit the atoms to escape from the spatial units, a force, exerted either by the walls of a container, or otherwise, is required for containment.

(144) The level of containment outside unit space is measured by the pressure, the force per unit area, dimensions $t/s^2 \times 1/s^2 = t/s^4$. The product PV of the pressure and the volume is the energy of the contained thermal motion, dimensions $PV = t/s^4 \times s^3 = t/s$. We identify the thermal energy level as the temperature.

(145) From (144), it follows that atoms of matter that are not confined, and therefore not subject to any pressure, cannot have temperatures above the very low levels at which they are able to escape from the individual spatial units. Free translational motion of an aggregate of matter likewise has no temperature effect. The motion of this aggregate as a whole is *independent* of the thermal motion of its constituents.

Temperatures of millions of degrees are currently reported as applying to individual atoms and molecules in the vicinity of certain astronomical objects. From the foregoing, it follows that these temperature estimates are erroneous. Temperatures of unconfined matter are in the range of a few degrees, not in millions of degrees.

(146) Ionization is produced by a transfer of speed displacement to rotational vibration from some other form of motion, under appropriate circumstances. Thermal motion is one such source. The degree of ionization of the atoms of an aggregate increases with the temperature of the environment in which the aggregate is located, and at extremely high temperatures all elements are completely ionized.

(147) From (95), the translational motion of masses, including the confined thermal motion, is outward. From (115), the electric ionization is also outward. Thus a further increase in temperature beyond the level of complete ionization ultimately brings the atoms up to a limiting level at which the sum of the outward ionization and the outward thermal motion is equal to unity. This unit outward motion then neutralizes one unit of the inward rotational motion. As indicated in (91), both units revert

to the linear status, converting the rotational vibration and a unit of the rotation to kinetic energy. *Mass* t^3/s^3 becomes *energy* t/s.

(148) The conversion factor relating a unit of mass to a unit of energy has the dimensions s^2/t^2 (the dimensions of the second power of speed) and unit magnitude. The energy equivalent of a mass is therefore the product of the mass and the second power of unit speed (the speed of light).

(149) As to the question of the result of further additions of thermal motion beyond the limiting point defined in (147) (the *destructive temperature limit* of the particular element under consideration), we must first return to (59), where we deduced that the maximum addition to the speed of a motion combination in any one dimension – that is, the amount that can be added to a zero base – is two units. In these terms of reference, the range is from zero to +2. In terms of displacement from the natural datum at unity, the range is from +1 to -1 (or from -1 to +1, as the identification of the conventional zero with +1 rather than -1 is purely arbitrary). The first added unit of speed eliminates the unit of speed displacement (+1), and the second adds a unit of time displacement (-1).

(150) Since there are no fractional units of speed, the reduction of linear speeds to levels below unity in the manner described in (44) can be accomplished only by introduction of units of inverse speed. This is motion in time, but the atom is moving gravitationally in space in the other two scalar dimensions, and the net total scalar motion is therefore in space. It follows, in accordance with (47), that the increments of motion in time in the range between zero and unit speed act as motion in equivalent space.

(151) Elimination of displacement in space (increase of speed) can continue only up to the unit speed level, at which point all displacement has been canceled. A speed greater than unity therefore cannot be attained by means of this process.

This is the explanation of the observed inability to accelerate material objects to speeds in excess of the speed of light by application of electrical forces.

(152) As noted in (151), the limit at the unit level is on the capability of the process, not on the speed itself, and it does not preclude an increase in the speed above the unit level by means of a different process. Where speed is available in full units, it may be added directly, up to the absolute limit, which, as stated in (59), is two, one-dimensional units. Because an increment of speed above unity is a scalar motion in time (equivalent space), the extension of the linear motion in space into the second unit is distributed over all three time dimensions. As in the rotational situation of (91), the existence of three-dimensional units of speed then makes intermediate speeds between unity and two full linear units possible.

(153) The aggregation of matter under the influence of gravitation noted in (34) applies to objects of all sizes. Because of the diversity of conditions there is no uniform aggregation pattern, but since gravitation is omnipresent, the average mass of all major classes of physical objects necessarily increases with advancing evolutionary development—with the evolutionary age, we may say.

(154) The process of aggregation results in the conversion of gravitational motion into thermal motion (heat). Coincidentally, there is a loss of heat from the surface of each aggregate, due to radiation. But the mass, which determines the rate of heat production, other things being equal, increases more rapidly than the surface area. The temperature of a large aggregate is therefore a function of the mass, as long as the aggregation process continues.

(155) Extremely high temperatures are reached only in very large aggregates of matter. If the aggregate is large enough to reach the destructive temperature limit of the heaviest element present, this activates the process of conversion of mass to thermal energy described in (147). We identify such an aggregate as a *star.*

(156) Since the maximum degree of electric ionization of an element is equal to its atomic number (127), the heavier elements have a greater content of ionization energy, and therefore require less thermal energy to reach the destructive temperature limit, the

temperature at which the total of these two energy components attains the unit level (149). If the stellar temperature continues rising, the elements reach their destructive limits in the inverse order of their atomic numbers.

(157) The principle that small numbers are more probable than larger numbers applies to the formation of the elements (with some modifications due to other factors). The heaviest elements are therefore present in the stars only in relatively small concentrations, and the energy released in their destruction is dissipated by radiation from the stellar surfaces. As successively lighter elements reach their destructive limits, the concentration of the individual element arriving at the limit increases, and eventually this process reaches an element that is present in quantities that produce more energy than the radiation mechanism can handle. The excess energy then blows the star apart in a gigantic explosion. We identify the overabundant element as *iron*, and the explosion as a *Type I supernova.*

Here the development of the theory leads directly to an explanation of a phenomenon for which no generally accepted explanation has been derived from astronomical theory.

(158) From (154), the temperature limit of a star is also a mass limit. From (153), the attainment of this mass limit is a result of advanced evolutionary age. The stars that explode as Type I supernovae are therefore mature stars of approximately the same mass. Thus all Type I supernovae have the same general characteristics.

The astronomers agree that all Type I supernovae are very much alike, but they have no explanation for the similarity.

(159) When the energy released in the supernovae explosion is added to the already high thermal energy level of the surviving portions of the interior structure of the star, a substantial portion of the explosion products are accelerated to speeds in excess of unity, in the manner explained in (152). From (46) and (47), the motion of these products takes place in the spatial equivalent of outward motion in time, which is inward in equivalent space. The aggregate of these very high

speed products thus undergoes a drastic spatial contraction, and appears to observation as a small star with a density vastly greater than that of any aggregate of matter existing in the terrestrial environment. We identify this high density aggregate as a *white dwarf star.*

(160) In ordinary stars (those with component speeds below unity) of a given class, the more massive stars are the larger; that is, they occupy a greater amount of three-dimensional space. From (46), the more massive white dwarf stars occupy the spatial equivalent of a greater amount of three-dimensional time, which is less equivalent space. According to the theory of the universe of motion, the more massive white dwarf stars are therefore smaller than the less massive ones.

This deduction is confirmed by observation.

(161) In ordinary stars the spatial density gradient from the surface to the center of the star is positive; that is, the center is the region of greatest density. From (46), the temporal density gradient of a white dwarf star is also positive, which means that the center of the star is the region of greatest density in time, or least density in the corresponding equivalent space. Thus the spatial density gradient is greatest at the surface, and the lowest at the center.

(162) Little or no translational motion in space is imparted to the white dwarf by the supernovae explosion. It therefore remains in the spatial region heavily populated with low speed explosion products, and accretes a substantial amount of these products by reason of its gravitational effect. The surface layers of the younger white dwarfs thus have a composition similar to that of their environment: predominantly hydrogen, with a minor amount of helium, and minute amounts of other elements. Because of the inverse density gradient (161), the hydrogen moves downward preferentially toward the center of the star, leaving the surface layers of the older white dwarfs enriched in helium.

This, too, is confirmed by observation. A substantial proportion of the white dwarfs are reported to have helium-rich surface

layers, extending up to "nearly pure helium atmospheres." Current astronomical theory has no explanation of this reversal of the normal density relations.

(163) In the supernovae explosion (157), the speeds imparted to the outer portions of the exploding star are less than unity. These explosion products therefore expand outward in space. Their motion is, however, subject to resistance from dispersed matter in the environment, and to the gravitational effect of the exploding aggregate as a whole, including the white dwarf that does not participate in the outward movement. These opposing forces ultimately terminate the expansion and initiate a contraction. Thus most of the ejected matter is eventually re-condensed into a star. The typical product of a Type I supernovae is therefore a double star system consisting of a diffuse A component on or above the main sequence and a dense B component (white dwarf or system of planets) below the main sequence.

This deduction from the premises of our theory *requires* the existence of double star systems as a direct consequence of the nature of the supernovae process, and explains why so many of these systems consist of dissimilar objects. The present state of astronomical knowledge in this area is described by the following quotation from a current astronomy textbook: "Our hopes of understanding all stars would brighten if we could explain just how binary and multiple stars form… Unfortunately we cannot."

(164) Any explosive event comparable in intensity to a Type I supernovae ejects some products at speeds greater than unity. The explanation given in (159) for the extremely high density of the white dwarfs is equally applicable to these other high speed products.

This accomplishes a significant simplification of astronomical theory, as the currently accepted explanation of the white dwarf density cannot be extended to such extremely dense objects as quasars, pulsars, x-ray emitters, and dense galactic cores, and separate explanations have had to be developed for the density of each of these types of objects.

Part III

Reaching Outward

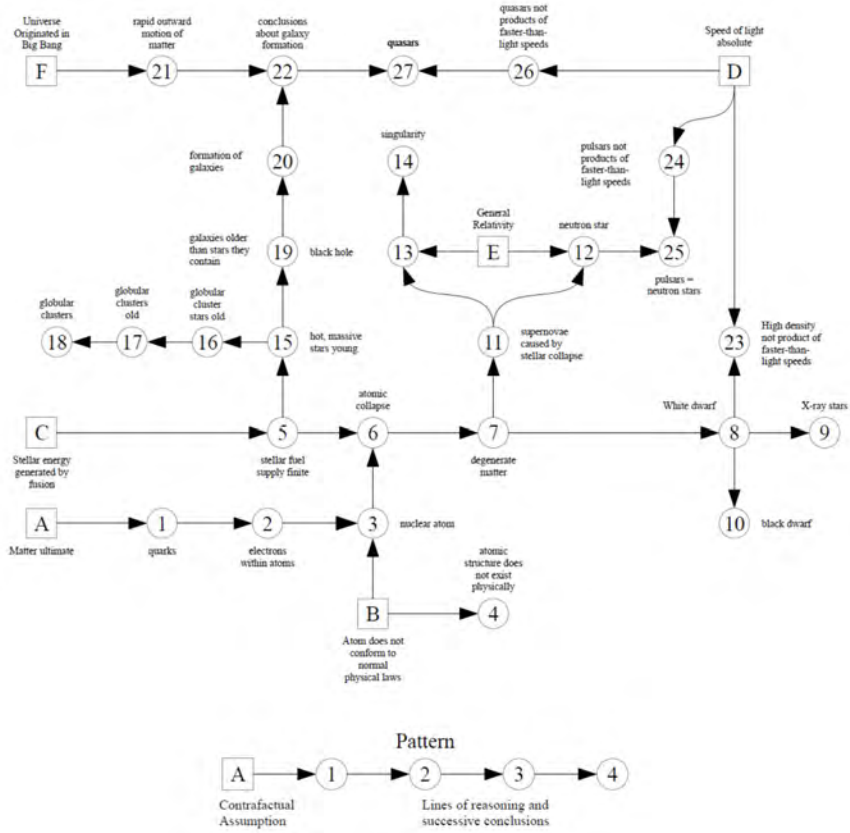
CHAPTER 10

The Mythical Universe

When the Reciprocal System of theory is applied to the astronomical situation the results are quite different from what can be found in the astronomical literature, so much so that the question arises: If the Reciprocal System is correct, how is it possible that the astronomers arrived at such totally different conclusions? The reason is that, just as we have done in the case of the Reciprocal System, the astronomers have taken the physical laws and principles to which they subscribe and have applied them to the astronomical situation. The difference is that we have the benefit of a general theory, one in which all conclusions in all fields are derived from the same set of basic premises. So that when we make the assumption that the laws and principles that we using are correct – as all of us have to do in order to establish the logical foundations of our results – we can do the whole thing with one assumption. The astronomers cannot do that, because conventional physical theory has no general physical structure. As described by one prominent physicist, Dr. Richard Feynman, in a quotation that I have cited previously, "The laws of physics are a multitude of parts and pieces that do not fit together very well." Thus when the astronomers assume the validity of the laws and principles that they are using, they have to make an assumption as to the validity of each one individually, amounting altogether to thousands of separate assumptions.

The astronomical universe includes many entities and processes, such as stars, planets, galaxies, and so on, that have to enter into any version of the structure. But those entities and processes are like the side panels and ornamentation on a building. They are attached to whatever framework may exist, and it is the framework that determines the character of the structure.

The structure is illustrated in the accompanying diagram. The assumptions contrary to fact are identified by letters, and from them the lines of reasoning, generally sound, lead out to the numbered conclusions, with arrows showing the direction of the reasoning.



Where the numbered conclusions refer to entities or processes that are totally non-existent, the names are indicated as well. Those numbered conclusions that are not accompanied by names refer to entities or processes that actually do exist, but that differ in some significant way from the description that we get from the astronomers.

An interesting feature of the diagram as a whole is that it illustrates the cumulative effect of several of these assumptions contrary to fact. On the upper left of the diagram, the numbered conclusions are subject to the effects of only one of these contrafactual assumptions, whereas on the other side of the diagram the effects of three, four, or five of these contrafactual assumptions converge.

The first of the assumptions contrary to fact, the one marked (A) on the diagram, is the assumption that the basic entities of the universe are elementary units of matter. That assumption seemed very reasonable when it was first made. But we now know definitely and positively that it's wrong, because we now know that there are processes whereby matter can be converted to non-matter and vice versa. And obviously, that means that matter cannot be basic. For example, radiation is not a form of matter, and matter is not a form of radiation. But matter can be converted to radiation. Consequently, it necessarily follows that both matter and radiation must be forms of some underlying entity, some common denominator, we may say. That's not a question of opinion or judgment; that's a necessary consequence of the observed facts. The relevance of that point in this present connection is that it sets a limit on the extent to which units of matter can be subdivided into simpler units of matter. For example, if we start with a rock and examine its structure, we find that it is composed of identifiable material sub-units that we call molecules. But if we continue that process, we eventually come to a material unit that is clearly not elementary, but for which we cannot find any sub-units.

The logical conclusion then is that we have arrived at the point that we know exists, the point where the material unit is not composed of material sub-units, but is composed of the common denominator, whatever that may be. That's the logical conclusion. But the physicists and the astronomers cannot accept that logical conclusion, because they are committed to assumption (A) which says that the basic units are units of matter. Consequently they have to go out and invent the units that they cannot find. That is the essence, the basis of the quark hypothesis, number one on the diagram. Many prominent scientists have recognized the fallacies in the quark hypothesis. Werner Heisenberg, for instance, was very critical of it. And he also recognized the necessity for a common denominator between matter and non-matter. He suggested that it might be energy; but he admitted that he couldn't see how energy could meet the requirements.

In a universe of motion the common denominator is, of course, motion. But strangely enough, these scientists who have been so able

to see the shortcomings of the quark hypothesis have not usually seen that exactly the same considerations apply to the particles that are supposed to be constructed of quarks – the hypothetical constituents of the atom. No one has been able to find them either. Of course the situation has been confused to some extent in this case by the practice of calling those hypothetical constituents by the names of observed particles. That practice, however, is totally unscientific.

Identity cannot be established by similarity in names. It has to be established by identity of the descriptions. In scientific terms, two entities are identical only if all of their properties coincide. The observed neutron, for instance, is an unstable particle: it has a life of less than fifteen minutes. And it's gregarious: it has a strong tendency to combine with almost anything that comes along. The hypothetical neutron constituent of the atom, on the other hand, has to be stable. And it has to maintain its identity even in places where the tendency toward combination is very strong. The unavoidable fact is that they are two totally different particles. Of course, the theorists tell us, the neutron is an accommodating thing, and if we put it in the atom, it will accommodate their theories by becoming stable and by discontinuing this awkward habit of combining with other things.

The situation with respect to the other hypothetical particles in the atom is no different. In fact Herbert Dingle tells us that we can't even imagine a particle with all of the properties that are required of the hypothetical electron constituent. But with these imaginary particles (number two on the diagram) the theorists have constructed an imaginary atom (number three).

But even with all of the leeway that they have had for making assumptions as to the properties of these particles of which they wanted to build an atom, they could not construct a plausible theory without making another assumption contrary to fact, the one marked (B) on the diagram. That is the assumption that the atom does not conform to the normal laws of physics. That's a drastic assumption, and because of that drastic assumption the people who put this structure together in the first place, have had to make the admission that their atom is not a real particle—that's number four on the diagram. As Heisenberg puts it, "It is in a way only a symbol." Irwin Schrödinger tells us, "If the question is asked, do the electrons actually exist on

these orbits within the atom, the answer has to be a decisive no." And Heisenberg specifically cautions us that we must not think that the physicists' atom is a material particle in space and time that exists objectively in the same sense that stones and trees exist. Then what sense does it exist in? Well, he tries to explain that, and he says this: "The atom of modern physics can only be symbolized by a partial differential equation in an abstract multi- dimensional space." Now when we translate that from the professional jargon of the physicist to the vernacular, we find that it says exactly the same thing that I have been saying. The physicists' atom is an imaginary atom constructed of imaginary particles. And in this connection I want to point out that these people that I have been quoting are not scientific heretics like the present speaker. They are eminent members of the group that puts this thing together in the first place. When the present-day physicist wants to apply quantum theory to his problems, it is Schrödinger's wave equation that he tries to solve. Now when he gets into difficulties, it's Heisenberg's principle of uncertainty that he calls on to get him out of those troubles.

In order to go any farther along this line of development, the astronomers have had to make still another assumption contrary to fact: like the first two, this one was borrowed from the physicists. It's their assumption as to the nature of the process whereby energy is generated in the stars. The physicists' attitude on this subject has never changed. They have contended from the very first that whatever the most energetic process known to them might be, that must be the stellar energy generation process, regardless of how much evidence might exist in any other field of science. The fact that they have had to change their ideas as to the nature of that process twice already, the last time under very embarrassing circumstances, has not changed their attitude in the least. Today there is ample astronomical evidence that their present assumption (C) is wrong, just as there was ample geological evidence in the nineteenth century to show that their then current assumption was wrong. But the physicists are no more willing to listen to the astronomical evidence today than they were willing to listen to the geological evidence during the long and acrimonious dispute with the geologists in the nineteenth century. And since the astronomers are not willing to put up with the

kind of fight that the geologists did, they have ignored or rejected the evidence from their own field, and have accommodated their evolutionary theories to the physicists' assumption (C).

The first conclusion that is derived from assumption (C) is that the supply of energy in the stars will eventually be exhausted – conclusion (5). The astronomers have then taken conclusion (5) and put it together with conclusion (3), the conclusion as to the nature of the atomic structure, and they have arrived at the further conclusion that the result will be a collapse of the atom.

While the lines of reasoning represented by the lines on the diagram are generally sound, there are a number of exceptions and the line of reasoning leading to conclusion (6) is one of them. One of the results of the application of thermal energy to a material aggregate is to introduce additional space between the atoms or between the molecules of the aggregate. And if we eliminate that thermal motion by exhaustion of the fuel supply, it's logical to assume that the exhaustion of the fuel supply also eliminates some further space in the interior of the atom that the thermal motion had nothing to do with in the first place. The justification for that kind of an assumption is very hard to see. Of course, some of the theorists tell us that when the support given by the thermal pressure is eliminated, the aggregate collapses of its own weight. But that is equivalent to assuming that material is heavier when it's cold than it is when it is hot. And there again, that's an assumption that's very difficult to accept. In the real world the atoms at the bottom of the pile are subject to the weight of all the overlying layers, regardless of whether they are hot or cold.

Conclusion number (6), then, claims that the material of the star collapses into a strange condition that they call "degenerate matter," in which all of the hypothetical space in the hypothetical atom has been eliminated and these hypothetical constituents are in a close-packed condition.

Since this degeneracy starts from a condition in which the material is cold, and therefore solid, it would seem natural to assume that the degenerate matter should be some sort of a super-solid. But no, that's not what they tell us. In some strange way it re-acquires some of the properties of a gas. Particularly, it acquires a substitute for the

thermal motion that it can no longer have. So that then instead of cold matter, we have an aggregate of hot degenerate matter – conclusion (7) – and they have identified that aggregate of hot degenerate matter with the white dwarf star – conclusion (8).

I have already mentioned item (9), which is the X-ray star. You will also note that the white dwarf, number (8) on the diagram, is connected with item number (23): but that's an incoming line. That refers to the effect of contrafactual assumption D on the white dwarf. Now this assumption D has an effect that is quite different in its nature from the effects of the other contrafactual assumptions. So it will be convenient to defer the effect shown by item (23) until we are ready to talk about the situation in the conclusions along the top of the diagram.

So let's move on then to conclusion number ten. The ersatz heat of the white dwarf is supposed to be radiated away in the same way as real heat, although nobody's explained why that should be true. And since it is radiated away, the white dwarf is presumed to gradually cool off, and eventually to become a black dwarf, a cold lifeless object that plays no further part in physical activity. These black dwarfs are purely hypothetical. There is no evidence whatever of the existence of any such thing. And there is no definite evidence that the evolution of the white dwarf is in the black dwarf direction. On the contrary, there is a great deal of evidence showing that some stars, and perhaps all of them, end their lives in gigantic explosions.

The astronomers have had to recognize that evidence, of course, and they've compromised: they've decided that the small stars collapse quietly, and end their lives as black dwarfs, and the big stars explode. And they have identified that explosion with the observed phenomenon now as the supernova – number (11) on the diagram. The effect of a gigantic explosion of that kind is to pulverize the material of the star and to eject it out into space in the form of a rapidly expanding cloud of dust and gas. But the astronomers have concluded, and they have some evidence to support that conclusion, that a residue remains at the scene of the explosion. And they have identified that residue as degenerate matter. But they have decided that because of the force of the explosion this matter is more degenerate than the degenerate matter of the white dwarfs.

And in some strange way that sounds like magic to me, all of the hypothetical constituents of that degenerate matter are converted to neutrons. So that what we have left is a star composed entirely of neutrons – a neutron star, number (12) in the diagram.

On the basis of some mathematical conclusions the astronomers have further concluded that there is a limit to the size of a neutron star, and they have decided that when the residue exceeds that size, the contraction under the influence of gravitation goes on until the surface gravity of the aggregate is so strong that no radiation at all can escape. What then exists, they say, is a black hole, conclusion number thirteen. Some theorists are not even willing to stop there. They contend that the contraction under the influence of gravity goes on and on until there's nothing left from the entire star but a single point – a singularity, in scientific jargon – conclusion (14).

As you can see from the diagram, all of these bizarre conclusions as to the products of the supernova explosion are subject to the effects of all four of the assumptions contrary to fact that I've already mentioned. And in addition they're subject to one more, which I've identified by the letter (E) on the diagram. This assumption is that the astronomers understand the mechanism of gravitation, which obviously they don't. Again I refer to Richard Feynman, who admits that "No one has given us the machinery of gravitation; all we have is the mathematical form." The author is evidently not familiar with the theory of the universe of motion, because we have identified the machinery; but his statement is correct in application to the conventional physics that the astronomers are using. This assumption leads directly to the one of the strangest inventions of modern astronomy: "Of all the conceptions of the human mind, perhaps the most fantastic is the black hole. Like the unicorn and the gargoyle, the black hole seems much more at home in science fiction or in ancient myth than in the real universe."Contrary to what one might expect, these are not my words or those of some other hard-boiled sceptic, but of Kip Thorne, one of the most enthusiastic advocates of the black hole hypothesis (*Scientific American,* December, 1974). Of course, he contends that black holes must exist anyway, no matter how fantastic they are. And after making that statement, he goes on to say this: "The laws of modern physics virtually demand that black holes exist." That is absolutely correct.

The whole point of my presentation then is that all of these absurdities, the black holes and the rest of them, are required by the current laws of physics and the current interpretations of those laws by the astronomers. And that is because those laws and those interpretations have not been purged of the effects of these assumptions contrary to fact that I have been talking about. The black hole is not science fiction; it's fictional science. The difference is that the science fiction writer knows and admits that he is using assumptions contrary to fact. The practitioner of fictional science either doesn't know or is not willing to admit that he is doing exactly the same thing.

Moving back now to the other side of the diagram, we note that one of the results of conclusion number (5), the conclusion as to the exhaustion of the fuel supply, is that the hot massive stars must be young because they are using their fuel at such a prodigious rate that the exhaustion must come relatively soon, astronomically speaking. This is an inherently improbably conclusion, and a great many astronomers have recognized that. Bart J. Bok remarked that "It is no small matter to accept as proven the conclusion that some of our most conspicuous supergiants, like Rigel, were formed so very recently on the cosmic scale of time measurement." And indeed this is no small matter. What Bok evidently realized is that the product is inconsistent with the process. Natural building processes are slow and gradual. The rapid processes, the catastrophic processes, are destructive. Some new combinations may emerge from those processes, but they're no more than incidental. The general effect of those processes is to tear down, not to build up.

It's generally agreed that the raw material from which the stars are formed must be diffuse matter in the form of dust and gas clouds, and if stars are currently forming, those must be cold clouds. The only known force that is capable of drawing the particles of those clouds together to form stars is gravitation and, due to the immense distances involved, the force of gravitation is very weak, and it takes a very long time to operate. The formation of a star is therefore a long, slow process and the initial product, being formed from cold material, is a cool star, not a hot one. In order to form a hot massive star, another long slow process is required. Thus the hot massive stars cannot be young; they must be relatively old. There is plenty of astronomical evidence

to support that finding, mostly based on the observation of the star clusters. Since we find that conclusion (15) is an erroneous result of an assumption contrary to fact, the same considerations also apply to conclusion (16), and they show that the astronomers have their age sequence upside down. They will undoubtedly object, claiming that they have proof to back up that age sequence. Nevertheless, closer inspection reveals that this evidence simply points to the existence of a sequence and not its direction. Additionally, the evidence that does relate to the sequence contradicts the astronomers' conclusions. The most conclusive of that kind of evidence comes from the small clusters that are located within the galaxy, rather than in its vicinity. Those clusters, the galactic, or open clusters, can be divided generally into two groups. In one group the constituent stars resemble those of the globular clusters. In the other group they are more like the general run of stars in the galactic arms, such as those in the solar neighbourhood. Both groups of clusters are expanding at measurable rates, and their star density, the number of stars per unit volume, is therefore decreasing. Since there is no reason that we know of why the initial conditions should be any different, it follows that the clusters with the greater average density are younger, and those with the smaller average density older. Here, then, we have something that is very rare in astronomy – an opportunity to determine the direction of evolution from direct observation. Nevertheless, the conclusion we have reached, namely that the denser clusters are younger, is the opposite of that reached by the astronomers.

This is not the only astronomical evidence that shows that astronomers have the sequence of stellar evolution upside down. Of particular significance in this connection is the age and origin of the globular clusters. If the stars of those clusters are old, as contended by the astronomers – conclusion (16) – then the clusters themselves are presumably old – that's conclusion (17). And the astronomers have therefore decided that they must have been products of the original process of galaxy formation, and are part of the galactic structure – that's conclusion (18). This view encounters some very serious difficulties. One of the most obvious of them is that the clusters do not participate to any significant degree in the galactic rotation, and that is very hard to explain if they are part of the galactic

structure. But since conclusion (18) is a logical result of this line of reasoning, stemming from assumption (C), to which the astronomers are committed, they have continued to hold on to this conclusion in spite of all the difficulties, hoping that they will ultimately go away.

But alongside this orthodox evolutionary view of the astronomers, there has in recent years grown up a new concept that contradicts the whole setup. And since that new concept is accepted quite widely in the astronomical profession, that profession is now in the awkward position where they, or at least a substantial segment of their profession, accept two contradictory explanations for the same thing. This new concept is the concept of galactic cannibalism. Quoting the astronomer Wallace Tucker: "The majority of galactic clusters are dominated by a single massive elliptical galaxy. Apparently these monster galaxies have eaten dozens of their smaller companions." Obviously, if the giant galaxies can swallow the spirals in their vicinity, the big spirals like ours have the capability of swallowing dwarf galaxies and globular clusters. And in the light of that information, the presence of large numbers of globular clusters surrounding every one of the major galaxies takes on a new significance. In the light of that information it is evident that those globular clusters are not part of the galaxy – they are external objects that are being drawn in where they can be conveniently swallowed.

It is worth noting in this connection that the motions of those clusters that are so difficult to explain on the basis of the astronomers' conclusions fit in very nicely with the cannibalism hypothesis. As described by the astronomer Otto Struve, they move "much as freely-falling bodies attracted by the galactic center." Of course, on the basis of this new concept, that is exactly what they are.

Returning now to conclusion (15), another one of the consequences of the astronomers' age sequence – conclusions (15) and (16) – is that stars must be currently forming in the galaxies, because there are a great many of these hot massive stars in the galaxies, particularly in the galactic arms, and according to the astronomers' viewpoint, those must have been formed fairly recently, and close to their present locations. That, however, confronts the astronomers with a difficult problem. As I mentioned earlier, the force of gravitation is capable under appropriate circumstances of pulling the particles of

the dust and gas clouds together to form stars. The difficulty arises because those appropriate circumstances do not exist in the galaxies.

In order to enable the force of gravitation to do the job unassisted, the dust and gas clouds in the galaxies would either have to be very much larger or very much denser than anything that now exists in the galaxies. In order to maintain their theories, the astronomers have had to try to find some auxiliary process that could work in conjunction with gravitation to produce these results. However, none of the processes proposed thus far has stood up to critical scrutiny.

Consequently, as admitted by Simon Mitten, "The process of star formation is almost a total mystery." When we correct the evolutionary direction, and turn the sequence upside down, the problem disappears; because on that basis there are no stars in the galaxy that are young in absolute terms. It's true that on that basis the stars of the globular clusters, or of the globular cluster type, are younger than the hot massive stars, but that does not mean that they are young in absolute terms. It does not preclude their having been formed in some region where the appropriate circumstances for star formation do exist, and having been brought into the galaxy by the capture process.

Since the astronomers accept this conclusion that the stars are currently being formed in the galaxies, they have had to arrive at another conclusion, number (19), namely that the galaxies are older than the stars that they contain. As expressed in one textbook, "According to current conceptions in astrophysics, the galaxies were born first in the universe, and the stars within the galaxies were born afterward. The main reason for believing this to be true is the fact that stars can be seen forming in the galaxies at the present time out of gas and dust." Of course, they cannot be *seen* forming; they are *presumed* to be forming based on the accepted theoretical conclusions.

The ideas as to galaxy formation, conclusion (21), are very vague. John B. Irwin describes them in this manner. "The Milky Way system, like other galaxies, is thought to have originated from a condensation or collapse of the intergalactic medium. The reason for the collapse is not known, and the details of the process are uncertain." What Irwin is in fact telling us is that astronomers know all about the galactic formation process, except the general nature of the process and the details. L. H. John puts the situation into perspective in this

statement: "The encyclopedias and popular astronomical books are full of plausible tales of condensation from vortices, turbulent gas clouds, and the like, but the sad truth is that we do not know how the galaxies came into being."

The reason for the difficulty the astronomers are having can be easily understood if it is recognized that their conclusions about the galaxies, number (22) on the diagram, are derived not only from conclusion (20), which is the result of the line of reasoning that we have been following, but also from conclusion (21) that directly contradicts conclusion (20). Conclusion (21) is derived from another assumption contrary to fact. That's the astronomers' assumption that the universe, or at least the present stage of the universe, originated in a gigantic explosion, the Big Bang as it is called. If they applied the same reasoning that they used in determining their ideas as to the consequences of the supernova explosion, then the explosion that they call the Big Bang would have ejected one part of the material of the universe out into space at high speeds, in the form of an expanding cloud, while another part of the material would have been left at the scene of the explosion in the form of a gigantic black hole. But they are already having serious difficulties in finding some reason why the universe is so isotropic. And if they put a black hole out in the middle somewhere, that would compound the difficulties. So they conveniently ignore what they decided over on the other side of the diagram and on this side of the diagram they decide that the entire contents of the universe – or as one textbook puts it, "All of the matter and all the radiation in the universe" – is ejected out into space in the form of an expanding cloud.

Now the problem comes then to explain how these particles could have been moving outward at high speeds ever since the Big Bang as required by conclusion(21), and at the same time aggregating into galaxies, as required by conclusion (20). If you stop to think about that for a little bit, you'll understand why the astronomers are having such difficulty, and why their ideas about the formation of galaxies are as vague as these statements have shown them to be.

We have now arrived at the point where we need to take contrafactual assumption (D) into consideration. As mentioned earlier, the effects

of that conclusion are exerted in a manner that is somewhat different from those of the others, which tear down the barriers that separate fact from fiction and permit the astronomers to extend their theories into regions that do not actually exist. The effect of conclusion (D), by contrast, is to set up barriers that prevent the astronomers from extending their theories into areas that actually do exist, and to force them to invent various kinds of substitutes.

The effects of this conclusion (D), which is Einstein's conclusion that the speed of light is an absolute speed limit, are expressed in the form of three prohibitions – (23), (24) and (26) on the diagram. Number (24) decrees: "Thou shalt not think of speeds greater than that of light in connection with the high density of the white dwarfs and the products of the supernova explosions." It is this prohibition that forces the astronomers into the strange contortions of thought that result in black holes and singularities.

Number (24) similarly dictates, "Thou shalt not think of speeds greater than that of light in connection with the intermittent radiation from the pulsars." Pulsars are number (25) on the diagram, and they get a double dose: they're subject to both prohibitions, namely (23) and (24). The result of this double prohibition can be seen in the present state of knowledge in the field. According to Dr. F. G. Smith, one of the leading investigators in the area, "the manner in which the pulsars are produced is not understood, and little is known about the mechanism of the radiation." That's the result of being prohibited from entering the field of high speeds.

Item (26) is another edict, "Thou shalt not think of speeds greater than that of light in connection with the quasars." Since almost all of the observable features of the quasars are a result of speeds greater than that of light, the astronomers are almost completely baffled by the quasars. The fundamental understanding of quasars is no more advanced than it was twenty years ago, when they were initially identified. A great deal of empirical information has been gathered in the intervening years, but little or no progress in understanding its significance. The general tendency in astronomical circles is to blame the physicists. As expressed by one prominent astronomer, Gerrit Vershuur, "the existence of quasars strongly suggests that we

are dealing with phenomena which present-day physics is at a loss to explain." That, of course, is true. But the astronomers cannot evade all responsibility. They did not have to accept all of the contrafactual assumptions that the physicists have made.

When the first pulsar was discovered, the regularity of the pulses suggested that they might be artificially created, and for a time it was fashionable to refer to them as messages from little green men. When more pulsars were found, it was realized that these must be natural objects, and the little green men were dropped. That may have been a mistake. This universe that the astronomers have worked so hard to construct is not of much use to us except for entertainment, because we are so constituted that we cannot deal physically with things that are not physical. We have to have things which, as Heisenberg says, exist in the same sense that trees and stones exist. But this universe that they have built would be a very appropriate home for the little green men, perhaps even degenerate little green men.

CHAPTER 11

Remodelling the Big Bang

Unquestionably, the most significant development that has taken place in cosmology in recent years is the replacement of the original Big Bang theory by a totally different hypothesis. The drastic nature of the conceptual change that is involved is well illustrated by comparing the following two statements:

> According to this [Big Bang] theory, the outward motion of the galaxies was caused by an exploding *atome primitif* which ejected them in all directions.
>
> –H. Alfven, 1966

> Many people (including some scientists) think of the precession of the galaxies as due to the explosion of a lump of matter into a pre-existing void, with the galaxies as fragments rushing through space. This is quite wrong… the expanding universe is not the motion of the galaxies through space, away from some centre, but is the steady expansion of space.
>
> –Paul Davies, 1981

While the new hypothesis still goes by the name of the Big Bang in most of the current literature, its conceptual basis is obviously very different from that of the original Big Bang. The objective of the change was to extricate cosmological theory from the multitude of difficulties that have been experienced in developing the original Big Bang theory in detail. To a large degree, the new hypothesis accomplishes this objective, but it does so at the expense of eliminating the explanatory content of the original theory.

The original version of the Big Bang provided an explanation of the expansion of the universe in terms of a known process, the explosion of an unstable aggregate of matter. Because of the gigantic

extension of the scale of the explosive process that was required in order to apply it to the universe as a while, this explanation was never very plausible, and its repudiation by a large segment of the astronomical community is readily understandable. However, it should be understood that the hypothesis of an inflationary universe that is now being offered as a replacement for the original Big Bang contains no explanation at all.

The observed fact that calls for some kind of an explanation is that the portion of the universe within the current observational limits is expanding in the context of the conventional spatial reference system. Some attempts have been made to extend the explosion concept to the space expansion hypothesis, and we occasionally hear expressions such as explosion of space itself. But an explosion is a process of a specific nature, one in which energy in a concentrated form is suddenly converted to kinetic energy and applied to acceleration of the residual products. Inasmuch as the revised Big Bang is something of a totally different character, it is not an explosion. It is a purely hypothetical concept for which there is no known physical justification. Aside from this clearly unacceptable suggestion, the new hypothesis simply accepts the expansion as a given feature of the universe, and makes no attempt at explanation.

It is evident that we will have to look further for any real explanation of the observed situation. Now that the original explosion explanation has been discarded, we need to find some other means of accounting for the observed outward motion of the galaxies. In approaching this task, the first point that should be considered is whether we have correctly identified the problem, specifically whether the galaxies are actually moving outward in the manner described by the astronomers. The principal evidence for this expansion is the Doppler shift in the frequencies of the radiation received from the distant galaxies. It is generally conceded that this frequency shift is sufficient to establish the reality of the outward movement. There is some controversy with respect to the applicability of the usual redshift-distance relation in certain special cases, but there appears to be adequate support for the conclusion that the normal galaxies are actually receding from our location at

the speeds indicated by the redshifts. However, this does not settle the issue as to whether the present interpretation of the motions of the galaxies is correct. We still have to consider the deeper question as to whether we are using the correct reference system.

It is ordinarily assumed that the stationary spatial coordinate system to which we customarily refer the motions of the galaxies is the natural reference system, the one to which physical activity actually conforms. On the basis of previous experience, this appears to be a logical assumption; Indeed, it seems so obvious that the possibility that it might be erroneous has seldom, if ever, been examined. But nature does not always agree with the results of human thinking, and when we are confronted with a difficult problem we always need to explore the possibility that our assumptions with respect to the factors that enter into this problem may be invalid.

The question arises, How can we determine whether nature prefers one reference system over another? The first step toward arriving at an answer to this question is to define the natural reference system. This presents no problem. Once the issue is raised, it is obvious that the natural reference system is that system in which an object that is, in fact motionless, does not move. We may further say that any object which has no independent capability of motion, and is not acted upon by any external force is, in fact, motionless. By definition, such an object must remain stationary in the natural system of reference.

What we need to do, then, is to identify some physical objects of this kind and see how they behave relative to our conventional system of reference. One class of such objects consists of the photons of light and other electromagnetic radiation. So far as we know, these photons have no capability of independent motion. No mechanism for the propagation of radiation has ever been discovered. Einstein is often credited with having provided an explanation of this phenomenon, but what he actually did was to dismiss the problem as too difficult. In *The Evolution of Physics,* he discusses the difficulties, and concludes that:

> Our only way out seems to be to take for granted the fact that space has the property of transmitting electromagnetic waves, and not to bother too much about the meaning of this statement.

By this time, after long years of effort have failed to find any trace of a motion-generating property in electromagnetic radiation, we may legitimately conclude that the photon is incapable of independent motion. In the absence of any evidence that it is, or can be, acted upon by any agency in open space, it can therefore be identified as motionless in the natural system of reference. But it is not motionless in the conventional reference system. In this system, photons move outward from their points of origin at the speed of light, if not subjected to external forces. Neutrinos and other massless particles follow the same pattern. Furthermore, the same is true of the galaxies at extreme distance. The matter of which these galaxies are composed does have a property, gravitation, which is capable of causing motion to take place, but this is the only such property that it possesses, so far as we are able to determine, and when the gravitational effect has been reduced to a negligible level by extreme distance, the galaxies, too, move outward at the speed of light.

If only one such class of objects was involved, we would have to consider the possibility that the objects of this class might contain a concealed motion-producing mechanism. But since three different classes of objects follow the same pattern, this possibility can be ruled out on probability grounds. We must therefore conclude that the objects of these three classes are, in fact, not moving; that is, they are motionless relative to the natural reference system. The reason why they have no mechanism for causing motion (or effective motion, in the case of the distant galaxies) is then evident. Objects that do not move have no need for a motion-producing mechanism.

Each of these motionless objects that is represented in the conventional system of reference as moving outward at the speed of light is observed to be moving in a definite direction in that reference system. It can be shown, however, that this direction is a result of the manner in which the motion is coupled to the reference system, and is not an inherent property of the motion itself. For this purpose, let us review what we know about the motions of the galaxies. Since all of the distant galaxies are moving outward away from us, it follows that, unless our galaxy is the only stationary object in the universe, a hypothesis that no scientist accepts today, we must be

moving outward away from all other galaxies. Consequently, we are moving outward in all directions. This means that our motion has no specific direction. Inasmuch as there is no reason to believe that our galaxy is unique in this respect, we can conclude that this is a general property of the galaxies, and that all galaxies (except those that are quite close, and are therefore subject to relatively strong gravitational forces) are moving outward without any specific direction. Such motion, which as magnitude only, and no inherent direction, is scalar motion.

The existence of scalar motion is not recognized by conventional science. In fact, motion is customarily defined in vectorial terms. But the motions of the galaxies, as we observe them, are definitely scalar, and the information now available regarding the motions of the photons and massless particles indicates that these are motions of the same kind. For present purposes it is important to recognize that scalar motions cannot be represented in their true character in the conventional reference system. This limitation of the capability of the reference system is new to science, and some may find it hard to accept, but its existence can easily be verified by a further examination of the galactic situation.

We can represent the motions of the distant galaxies in the usual manner, as radially outward from our location, only if we assume (1) that our galaxy is motionless, and (2) that each of the other galaxies has a specific direction of movement. But we know that both of these assumptions are false. Aside from the exception stated, all galaxies, including ours, are moving outward in all directions. It follows that the representation of the motion of any galaxy in the conventional reference system can only show the change of position relative to some one location in that system of reference. We take our galaxy as the reference location, and we see galaxy X as moving in the direction AX, where A represents our location. But observers in galaxy B see galaxy X as moving in a totally different direction BX, those in galaxy C see it moving in the direction CX, and so on.

We may generalize the relation between scalar motion and the conventional reference system by saying that scalar motion can be represented in this reference system only by the use of a reference

point, a point in the moving system that is coupled to the stationary reference system by arbitrarily assuming that it is motionless (from the scalar standpoint) in that system of reference. As has been indicated, the usual reference point for the motion of the galaxies is the position of our own Milky Way galaxy. For the photons and the massless particles, the reference point is the point of origin, and the direction taken by each individual particle is determined by chance.

All of the objects that we have identified as motionless in the natural reference system are observed in the conventional system of reference as moving outward from their respective reference points in the same manner and at the same speed, the speed of light. It follows that this is the relative motion of the two systems; that is, the natural system of reference is moving outward at the speed of light relative to the conventional system.

This outward movement of the natural reference system carries all physical entities with it, the consequence being that objects which are motionless in the conventional reference system are, in fact, moving inward at the speed of light. This finding revolutionizes the problem of identifying the motion mechanisms. Instead of having to look for one mechanism whereby electromagnetic radiation is propagated, another to account for the motion of massless particles, and still another to explain the recession of the most distant galaxies, all that we need to do is to identify a mechanism whereby the atoms and particles of matter are able to move inward toward each other. This is easily done. It is true that the nature of this mechanism whereby matter is capable of self-generated motion has never been identified by previous investigators, but the existence of such a mechanism is incontestable. This mechanism is gravitation, a known property of matter that accomplishes exactly what is required in order to counterbalance all or part of the effect of the outward progression of the natural reference system. It moves each gravitating object toward all others.

From the fact that the gravitational motion is the inverse of the outward motion, or progression, of the natural reference system, it can be recognized as an inward scalar motion. It is generally regarded as a force, but there is no conflict here, as force is defined

in such a way (by Newton's Second Law of Motion) that it is a property of a motion. Einstein's "principle of equivalence," the key feature of his General Theory of Relativity, asserts that gravitation is equivalent to a motion. On the basis of the findings that have been described herein, we can go a step farther and say that it is not only *equivalent* to a motion; it *is* a motion. But it is not vectorial motion, the only kind of motion that Einstein appears to have recognized. Identification of gravitation as an inward scalar motion accounts for the observed radial character of the gravitational force field, and eliminates the need for postulating a distortion of space by the presence of matter, one of the most questionable expedients employed in the construction of the General Theory.

Because it is generated by a fixed relation between the two reference systems, the outward movement of physical objects due to the progression of the natural system always has the same magnitude: the speed of light. But the gravitational effect varies with the distance between the objects, the interaction of these two opposing scalar motions under different conditions is therefore capable of explaining a wide variety of results within the conventional reference systems, all the way from net speeds that approach the speed of light in the outward direction to net speeds that approach the speed of light in the inward direction. In particular, the range of speeds involved in the galactic recession, the specific subject of the present inquiry, is fully explained by the combination of the two oppositely direction scalar motions. At great distances, the gravitational attraction is weak, and the outward motion, observable as the galactic recession, predominates. As the distance decreases, the gravitational force becomes stronger, and the net outward motion decreases, until at a certain point, the gravitational limit, we may call it, the inward and outward motions are equal, and the net motion is zero. Inside this limit there is a net gravitational (inward) motion.

Here, then, we have arrived at an explanation of what is currently regarded as the primary cosmological problem, that apparent expansion of the universe, and we have reached it purely on the basis of existing knowledge, without introducing anything new or making any special assumptions. Like Copernicus in his day,

all that we have found necessary is to look at our problem from a different point of view, to use a reference system that gives us a more complete and correct picture of the factors that are involved.

The universe, we find, is not expanding. On the contrary, the general direction of movement is inward. The aggregates of matter, the galaxies, are growing. The cannibalism that is currently being attributed to the giant galaxies in the centers of relatively dense clusters is not peculiar to the giants; it is a general feature of the universe that applies to aggregates of all sizes.

CHAPTER 11

Astronomical X-Ray Sources

Recent advances in techniques and equipment for X-ray observation of astronomical objects have resulted in the accumulation of enough information to enable checking the general nature of the observational results against the theoretical picture derived from development of the consequences of the postulates of the *Reciprocal System of physical theory,* the *RS theory*, as we will call it for convenience. X-rays can, of course, be produced in relatively small quantities by a number of different processes, but the RS theoretical development indicates that the source of the very strong radiation in this frequency range that is generated in astronomical objects is radioactivity from matter which has reverted to speeds below unity (the speed of light) after having remained at a higher speed long enough to attain isotopic stability at the ultra-high speed.

This is the inverse of the process that theoretically gives rise to radiation at radio frequencies from the matter in objects such as quasars and pulsars that has just recently crossed the boundary in the other direction, from low speeds to ultra-high speeds, and is in the process of attaining isotopic stability at the ultra-high speeds. According to the theoretical findings, as explained briefly in *Quasars and Pulsars*, and in more detail in a supplement to that book entitled *Quasars – Three Years Later,* the factors which govern atomic stability are, like all other properties related to the speed, inverted at the unit level. Under low speed conditions, the zone of isotopic stability in the normal galactic environment is above the basic level at which the atomic mass is twice the atomic number. In an earth-like environment, the deviation of the theoretical center of the zone of stability from this basic level is 2Z/156.44 atomic mass units, where Z is the atomic number. At ultra-high speeds, the

direction of the mass increment is reversed, and in a corresponding environment, the zone of stability is centered at 2Z/156.44 atomic mass units *below* the basic level.

This means that any matter which moves from low speed to ultra-high speed, or vice versa, is outside the zone of stability at the new speed, and must undergo a radioactive process to move into the stable zone. For example, the center of the zone of stability for the element silver, Z = 47, is 14.12 above the basic level, 2Z = 94 amu at low speeds, and 14.12 amu below this basic level at ultra-high speeds. A silver atom crossing the unit boundary therefore has to undergo a radioactive change of isotopic mass from 108 to 80, or the reverse. At the low speeds of our ordinary experience, this radioactivity involves the emission of high frequency radiation: x-rays and gamma rays. At ultra-high speeds, the emitted radiation is in an equivalent frequency range on the other side of the unit level, which puts it in the radio range.

The discrete astronomical sources of strong radiation of these two types are objects in which such radioactive transitions are taking place on a vast scale; where extremely large quantities of matter have been transferred from one speed range to the other in a relatively short period of time. The radio emitters are explosion products – quasars, radio galaxies, pulsars, etc. – composed wholly or in part of particles that have been accelerated from low speeds to speeds greater than unity by stellar or galactic explosions. Inasmuch as there are no *aggregates* of ultra-high speed matter in the material (low speed) sector of the universe, other than these explosion products, the x-ray and gamma ray emission originates from those of the explosion products which return to the low speed range after spending a substantial period of time at the ultra-high speeds.

In the chaotic conditions that exist in the turbulent products of the explosion of a star or galaxy, some of the atoms or particles that have acquired ultra-high speeds drop back into the low speed range temporarily by reason of loss of energy in encounters with other particles, and emit high frequency radiation at the low speed. All of these explosion products are therefore x-ray sources as well as radio emitters, but the high frequency radiation is relatively minor in the quasars, and also in the pulsars (except under some special

conditions that will be discussed later), because the speed of these objects is great enough to enable escape from the material sector, and the aggregate as a whole never returns. The high frequency emission from the low speed products of galactic explosions, the radio galaxies, is likewise relatively weak because only a small percentage of the mass of these objects is moving at ultra-high speed, and while this matter was accelerated to the high speed suddenly, its reversion to the low speed range is spread out over a long period of time.

The strong x-ray emitters are explosion products of intermediate energy, those in which the entire aggregate initially acquires speeds that are greater than unity, but are not high enough to permit escape from the material sector. These ultra-high speed aggregates that remain in the low speed environment gradually lose energy to that environment, and ultimately drop back below the unit speed level. The speeds of the component particles follow the same course, and these aggregates therefore become x-ray emitters in the stage of their existence immediately following their return to the low speed range. The intermediate-energy explosion products are of two kinds. The Type I supernova is not energetic enough to raise its high speed explosion product, the white dwarf star, to the escape speed, and the entire white dwarf aggregate eventually returns to the low speed status after spending some time at the ultra-high speed. The speeds of the products of the more powerful Type II supernovae are distributed throughout the entire range below the maximum value, and, although the fastest particles are able to escape in the form of pulsars, there are some portions of the explosion products that acquire speeds greater than unity, but below the escape limit. Like the white dwarfs, this material, which forms part of the objects that are observed as supernova remnants, reverts to the low speed status in time. Both kinds of products emit x-rays while the isotopic changes required by the inversion at the unit level are taking place. The relatively strong discrete x-ray sources are therefore mainly white dwarf stars and supernova remnants (or extra-galactic aggregates containing these or similar objects).

In what we may call *Stage 1,* the immediate post-ejection period following the Type I supernova explosion in which the white dwarf star is formed, this star is expanding in time, which means that from

a spatial standpoint it is contracting. In this stage, the constituent particles, newly raised to ultra-high speeds, are emitting radiation at radio frequencies as they move toward isotopic stability at these speeds. Such a star is observable only as an otherwise unidentifiable source of radio emission. A great many such sources – "blank fields", as they are often called by the optical astronomers – have been located, and presumably some of these are Stage 1 white dwarfs.

When the energy loss to the environment has been sufficient to terminate the contraction, a process of re-expansion begins, the first portion of which may be called *Stage 2* of the white dwarf existence. In this stage an increasing number of the constituent particles of the star lose enough energy to drop below unit speed. The atoms of which these particles are composed then make the radioactive transition to the upper zone of stability, emitting x-rays and gamma rays in the process. In the early part of this stage, the radiation at optical frequencies is minimal, and the white dwarf is still not optically visible, manifesting itself only as a source of high frequency radiation, and in its gravitational effect on its companion star. As the re-expansion proceeds, the white dwarf star continues accreting portions of the diffuse material ejected in the original supernova explosion, together with other matter from the environment, and gradually builds up an outer shell of low speed matter. This shell, increasing in thickness, absorbs more and more of the radiation from the interior, and ultimately the x-ray emission ceases. The star is then in *Stage 3,* the stage in which it is readily observable optically, and has the recognized white dwarf characteristics.

From theoretical considerations it has been deduced that the equivalent of a pressure builds up in the interior of the white dwarf as the expansion toward gravitational equilibrium continues, and in *Stage 4* this pressure breaks through the overlying material periodically, exposing the radioactive material from the interior. During these outbursts (novae and related phenomena) x-ray and gamma ray emissions are again observable; that is, the high frequency radiation of Stage 2 is resumed on a *periodic* basis.

Summarizing, we find from theory that the relatively strong discrete sources of x-ray emission are:

1. white dwarf stars, not optically visible, in the early part of Stage 2 of their existence,
2. novae and nova-like variable stars (Stage 4 white dwarfs),
3. local concentrations of matter, or diffuse clouds of matter, in remnants of supernovae, and
4. extra-galactic aggregates containing these or similar sources.

Here, then, is the general theoretical account of the principal sources of radiation in the x-ray range now being observed from astronomical sources, as derived from the basic postulates of the RS theory. As can be seen from the foregoing explanation, all of the information required to put this description together was already available in previous publications dealing with this system of theory. It had already been determined that the explosion products – quasars, pulsars, white dwarfs, etc. – theoretically undergo inverse radioactivity on crossing from the low speed to the ultra-high speed range, and thereby produce radiation at radio frequencies. It had also been found, from theoretical considerations, laid out in *Quasars and Pulsars,* that certain of these explosion products (quasars, for example) acquire sufficient speed to escape from the material (low speed) sector, whereas others (white dwarfs, for example) do not attain the escape speed, and eventually return to the normal, relatively low, speeds of that sector. All that was needed to complete the theoretical picture was a recognition of the rather obvious fact that the process previously deduced as the source of the radiation at radio frequencies from the products of stellar and galactic explosions also works in reverse to produce x-rays and gamma rays from those of the explosion products that return to the low speed range.

We thus have a theoretical definition of the origin and properties of the x-ray emitters that has not been constructed to fit the observations, in the manner in which most scientific theories are devised, but was already in existence *prior to the discovery* of the astronomical x-ray emission. The close agreement between this preexisting theory and the observational information thus far obtained is therefore highly significant.

In undertaking a correlation between theory and observation, we will reserve the emission in the supernova remnants for later

consideration, and will begin with the observations of the other strong galactic sources, which, the RS theory tells us, are early (Stage 2) white dwarfs, or nova-like late (Stage 4) stars of this class. According to the previously published theoretical account of the origin and nature of the white dwarfs, they are components of binary (or multiple) systems in which they are associated with stars that originate, coincidentally with the white dwarfs, as infrared stars, and pass through a supergiant or giant stage as they move toward gravitational equilibrium on the main sequence.

Inasmuch as the observable white dwarfs appear to be distributed rather uniformly among the stars in the disk of the galaxy (as the theory requires), it can be expected that both the continuous and the periodic x-ray emitters will share this uniform distribution, and the x-ray sources of this class should therefore be concentrated toward the galactic center and the galactic equator in the same manner as the general run of disk stars. The observed distribution of the sources is in full agreement with this theoretical expectation.

Thus far, only about 20 percent of the x-ray emitters that have been identified as stars are definitely known to be members of binary systems, and the theoretical conclusion that they are all members of binary or multiple systems has been confirmed only to that extent, but there is no evidence to indicate that the remainder are not components of binaries. Indeed, it was suggested by R. Giacconi at a symposium that the evidence from observation warrants adopting "a working hypothesis that all galactic x-ray sources are either members of a binary system or supernova remnants."[1]

As stated in a recent review article, the observations indicate that the x-rays "must originate from relatively small, compact objects." The theoretical identification of these objects with the white dwarfs is in complete agreement with this and the previously stated conclusions from observation. The stars currently recognized as white dwarfs are "relatively small, compact objects"[2]; they are members of binary systems in which they are associated with stars on or above the main sequence; and they are distributed in roughly the same manner as disk stars in general. These same statements are likewise applicable to the stars not currently included in the white dwarf class, but theoretically identified as Stage 4 white dwarfs, the novae and nova-like variables.

The RS theory and observation are thus in complete harmony. But the predominant astronomical opinion rejects this straightforward interpretation, and invokes some products of the imagination to explain the x-ray emission: "The main candidates [as x-ray emitters] are black holes and neutron stars – though a few observers may hold out for white dwarfs."[3]

In considering the conflict between the RS theory and current astronomical thought, it should be realized that there is no independent evidence of the existence of such things as neutron stars or black holes; they are *purely* hypothetical, and they are brought into the x-ray situation only because the accepted theory of the nature of the white dwarfs imposes limits on the range of sizes and densities of these objects: limits which are wholly theoretical and without factual support of any kind. From an *observational* standpoint, all of the ultra-high density non-pulsating stars are alike. There is no physical evidence to indicate the existence of any division by sizes such as that which is required by current theory. The truth is that the inability of the conventional white dwarf theory to account for the full range of this group of observationally similar objects is a serious defect in the theory: one which, in most fields of science, would be enough to prevent its acceptance. But in this case, the weakness in the white dwarf theory is used as an argument *in favour* of the black hole theory, or at least, as conceded by the proponents of the theory, it is a "key link" in that argument.

When the hypothesis of black holes and neutron stars was first proposed as an explanation of x-ray emission, it was recognized in its true character as an extreme case of speculation. As seen by P. Murdin, black holes are a "solution looking for a problem." Only a "counsel of desperation," he said, would suggest calling upon such a hypothesis.[4] Of course, even far-fetched speculations are scientifically legitimate, and sometimes serve a useful purpose, but unfortunately, there is a tendency to forget that they have no tangible basis. As they are repeated over and over again, they gradually acquire a standing merely by virtue of the repetition, and soon the observations which they were invented to fit begin to be accepted as evidence in their support. Anticipating this sort of a development, O. R. Burbidge sounded this note of warning:

> Will it be firmly announced that black holes and/or neutron stars have been discovered... and shall we then build on this shaky foundation to explain even more about the universe?[5]

Burbidge's apprehensions have been fully justified. The *observational* status of the black hole hypothesis is no firmer now than it was when his comments were made. It has been *enlarged* by the addition of subsidiary hypotheses, but aside from the things that hare been deliberately built into the theory by means of these additional hypotheses (for example, a reason why the emitters are members of binary systems), none of the new items of information that have been derived from observation, such as those discussed in these pages, can be explained by means of the black hole theory. Since every additional unexplained or contradictory item weakens the theory, its status has deteriorated to that extent. Notwithstanding the reluctance of those who are working in this area to concede the point, black holes and neutron stars are still pure speculations, just as they were when first proposed. "Black holes", say Fabian and Pringle, "are still in the realm of science fiction."[2]

This black hole hypothesis is another example of the results of the general unwillingness to reevaluate existing ideas or theories when new information becomes available. When the existence of matter at ultra-high densities was first brought to light by the discovery of the white dwarf stars, it was found possible to devise a theory which appeared plausible in the light of the facts that were known at that time. But later, when the same phenomenon – ultra-high density matter – was encountered in the form of quasars, where the existing white dwarf theory was obviously inapplicable, instead of taking the hint and reexamining the white dwarf situation, the theorists have devoted their efforts (so far unsuccessfully) to finding some different explanation to fit the quasars.

Then, when the same ultra-high density showed up in the pulsars, still another explanation was required, and this time the neutron star hypothesis was invented. Now we again meet the same ultra-high density in the constituents of the x-ray emitters, and since none of the previous explanations fits this case, we must again have a new theory. Here the resourceful theorists bring out the black hole. So in order to explain the different astronomical manifestations of *one* physical

phenomenon – ultra-high density matter – we have an ever-growing multitude of separate theories, one for the white dwarfs, one for the pulsars, at least two for the x-ray emitters, several for the dense cores of certain types of galaxies, and no one knows how many for the quasars.

The application of the RS theory to the problem merely accomplishes something that was long overdue in any event: a reevaluation and reconstruction of the entire theoretical structure – particularly the white dwarf theory – in the light of the vastly greater amount of information now available. This theoretical investigation shows that the ultra-high density results, in all cases, from the same cause, and all of the ultra-high *density* stars, regardless of whether we observe them as white dwarfs, pulsars, x-ray emitters, or unidentified sources of radio emission, are identically the same kind of objects, differing only in their speeds and in the current stage of their radioactivity. The existing multiplicity of theories is not only confusing, but definitely misleading, and wholly unnecessary.

The next significant item of observational evidence that should be noted is that the "normal stars in x-ray binary systems are O and B supergiants."[6] Theoretically, the companions of the white dwarfs in the *largest* binary systems should be supergiants, when these companions first reach the stage where they are optically visible. Since these large systems are the strongest emitters, they are the easiest to identify, and the fact that the first few systems to be located have supergiant components is therefore in accord with the theoretical expectation. However, the range of white dwarf companions in the optically observed binary systems extends all the way to the main sequence. It can be expected, on the same basis, that as observational techniques and facilities are improved, some infra-red stars (earlier than supergiants), some giants (smaller than supergiants), and some main sequence stars (later than supergiants), will also be found associated with x-ray emitting white dwarfs. Indeed, the observations already reported include an infra-red component of Cygnus X-3.

According to the RS theory, this diversity in the type of the companions of the white dwarfs is a result of differences in the relative rates of evolution of the two components. The binary systems containing observable white dwarfs (Stage 3, no x-ray emission) evolve toward the main sequence, the giant star contracting and

the white dwarf expanding, both moving toward gravitational equilibrium. As mentioned earlier. Stage 4, the latter portion of the expansion period, is characterized by periodic outbursts of an explosive nature, and the normal white dwarf is therefore followed by a succession of novae and nova-like variables. The general nature of these "cataclysmic variables" (a term used to apply to "novae, recurrent novae, dwarf novae, and nova-like variables") is clearly in agreement with the conclusions of the RS theory. As the foregoing article says, such a star "is a close binary system in which the primary component is a white dwarf. The secondary is a normal star."[7]

The astronomical community is currently unwilling to accept the theoretical conclusion that the cataclysmic variables are *successors of* the normal white dwarf stars, because the observations do not define the direction of the evolution of these systems, and conventional thinking *assumes* that the normal white dwarf is in the last evolutionary stage of optically visible stars, the last stage before they descend into the hypothetical realm of black dwarfs, neutron stars, and black holes. But the conclusions of the RS theory with respect to the direction of evolution of the white dwarfs are now given powerful support by the x-ray observations, which reveal that there are, in fact, "x-ray novae," as asserted by the theory. Elliot and Liller report that there is "some compelling observational evidence that relates the nova phenomenon...with at least some galactic x-ray sources." These authors concede that the x-ray emission comes only from some of the novae, or only at some times. "Certainly not all old novae are galactic x-ray sources," they say.[8] The observations thus agree with the theoretical finding that only the interior material of the Stage 4 star is emitting high frequency radiation, and that, as a consequence, the x-rays are observable only when the explosive outbursts bring the interior material to the surface.

As noted earlier, there are some special conditions under which it is theoretically possible to have x-ray emission from pulsars, radiation which, like the radio emission from these objects is received in regular pulses. It was pointed out in *Quasars and Pulsars* that the two components of a binary system do not necessarily undergo supernova explosions at the same time, even though both are of the same age, and it is therefore quite possible that a second such

explosion may take place in the remnants of the first. In such a case, relatively rapid accretion of matter by the second pulsar can be expected. This accreted low-speed matter will interact with the adjacent portions of the pulsar, and will reduce the speeds of some of its constituent particles below the unit level, causing the emission of x-rays. If the accretion proceeds far enough while the pulsar is still within observable range, the optical radiation from the accreted matter will also be visible. Inasmuch as all of the three types of radiation, radio, x-ray, and optical, originate in the rapidly moving pulsar, the pulsation rates will be the same for all.

The observed characteristics of the pulsar 0531+21 in the Crab Nebula are in full agreement with this theoretical pattern. Optical, x-ray, and radio emissions have been observed, and all have the same pulsation period. The x-ray emission, produced in the outer regions of the pulsar, is stronger than the radio emission from the interior, as would be expected. This pulsar is located approximately in the center of a mass of diffuse material, the characteristics of which are such as to lead to the conclusion that it is made up of two dissimilar components, suggesting that it originated in two separate events. Furthermore, a second pulsar, 0525+21, has been located in a position which is generally believed to indicate association with this nebula.

The recently reported discovery of a pulsar, 1913+16, which appears to be a member of a binary system and *not* an x-ray emitter, is of interest in this same connection, inasmuch as these characteristics suggest that this is a case where the pulsar has originated from the *first* explosion in a binary system, rather than the second. Like the Crab Nebula pulsar, 1913+16 is the only member of its class thus far discovered. Indeed, it was stated in Nature only a few months before this discovery that "no known pulsar is a member of a binary system". The scarcity of such objects indicates either that our galaxy is not old enough to have many Type II supernova explosions of binary systems (second generation stars), or else that the interval between the two explosions is ordinarily considerably greater than in the two known cases.

Another situation in which x-ray emission from a pulsar could theoretically occur is that which would exist if, for any reason (perhaps a continuation of heavy accretion), the pulsar loses so

much energy that it drops below the escape speed. In that event, it will follow the same course as the white dwarf, eventually returning to the low speed range, and emitting high frequency radiation in the process. Ultimately, it will be indistinguishable from the ordinary white dwarf. Unlike that star, however, the retarded pulsar will be returning from an unobservable condition at a (temporal) distance outside the observable range, and in reentering the observable region it will pass through the same pulsation zone that it crossed on the way out. While in this zone, the x-ray radiation will be pulsed in essentially the same manner, and within the same range of pulsation periods, as the radio emission from the outgoing pulsars.

The x-ray radiation from accelerating pulsars should always be accompanied by strong radio emission, and pulsed x-rays without any more than a weak radio accompaniment can theoretically be regarded as originating in decelerating pulsars. Another distinguishing characteristic is the direction of change of the period. The periods of the accelerating pulsars are, of course, increasing. Those of the decelerating objects are decreasing, but the rate of change is relatively slow, and within the current accuracy of measurement, the period may appear to be constant. Aside from that of the Crab Nebula pulsar, 0531+21, no increasing x-ray pulsation periods have been found. The other observed sources of pulsed x-rays therefore appear to be decelerating pulsars. In the case of one of them, Centaurus X-3 (4U 1118-60), it has been specifically reported that the pulse rate is *not* slowing down.

The near absence of observable x-ray pulsars in the accelerating stage tends to support the theoretical conclusion that the observable portion of this stage, the period of time during which a pulsar is observable after the supernova explosion, is very short. The theoretical basis of this conclusion appears to be firm, inasmuch as the age of the oldest pulsar thus far located, calculated from its pulsation period as 9100 years, is consistent with the maximum observable life, calculated from gravitational fundamentals as 13,000 years (where the gravitational restraint is exerted by one solar mass). However, the only definite observational evidence that was available to support such a short life at the time the foregoing values were published in Quasars and Pulsars was the observed ratio

of pulsars to white dwarfs. As pointed out in the book, this ratio would lead to an improbably long life for the white dwarfs if the pulsar life exceeded the calculated figure by any substantial amount. In the meantime, further observational support has accumulated, including this confirmation of the theoretical deduction as to the rarity of observable x-ray pulsars.

Additional confirmation of a more direct nature has come from the supernova remnants. These remnants have been more carefully examined for evidence of association with the pulsars, and it is now conceded that this evidence is conclusive in only two cases – the Crab Nebula (900 years) and the Vela remnant (currently estimated at 11,000 years, calculated at 1500 years). Eric M. Jones summarizes the situation as follows:

> Although the numbers of identified supernova remnants and known pulsars both approach 100, only two well-established pulsar-SNR pairs are known.[9]

The fact that associations of greater ages are not *observed* is strong support for the theoretical conclusion that they are not *observable* for longer periods of time. The possibility that the pulsars and the remnants may have moved apart since the explosions, so that association is no longer evident, has been investigated, but it is difficult to obtain any specific evidence that such a separation has actually occurred. On the other hand, there *is* evidence that separation of the two objects does not *always* occur, since the pulsars in the observed associations are centrally located, as most, if not all, of them theoretically should be. This available evidence is conclusive, as the conclusion with respect to a limiting age in the neighborhood of the calculated figure is essentially the same regardless of whether *all* of the pulsars remain within the remnants, or only *some* of them remain. In either case, if the very low age limit did not exist, pulsars should be found associated with at least *some* of the remnants of greater age.

Current views as to the pulsar life, which differ radically from the conclusions of the RS theory, are based on the *assumption* that the increase in the period of pulsation is linear with respect to time. On this basis, ages in the range from 103 to 108 years are obtained by dividing the period by the rate of increase, expressed on an annual basis. But the

finding of the RS theory that the age is proportional to the square root of the pulsation period means that, instead of being a simple quotient as assumed, the age is inversely proportional to the effective rate of change of the period. It is necessary to specify that this relationship applies to the *effective* rate of change because the theory indicates that the measured quantity, the continuous change, is the third power of the effective rate, the difference being taken up in time adjustments (sudden changes in the period similar to the observed phenomena known as "glitches") resulting from the pulsar motion in time. Theoretically, therefore, the age of the pulsar is inversely proportional to the ⅓ power of the measured rate of change of the period.

Application of this relation to the two youngest pulsars for which complete data are available arrives at an age ratio of 1.5. On the basis of 900 years for the Crab pulsar, this gives us 1350 years as the age of Vela X (4U 0833-45). The age of this pulsar calculated directly from the period is 1480 years. The agreement is within ten percent, which is probably as close as we can expect at the present stage of observational and theoretical development. Because of the many factors that affect the "fine structure" of the pulsation periods, and the greater proportionate effect of these factors at the lower rates of change, the individual deviations of the ages similarly calculated for the pulsars of longer periods exceed ten percent in many cases, but the *average* deviation is even less, except at the very low rates of change. For example, a compilation of pulsar data by includes 20 pulsars with periods lengthening more than 0.100 n sec per day, and the average deviation between the ages of these 20 pulsars calculated from the rate of change of the period and the ages calculated directly from the period is only four percent.[10] This is clearly a confirmation of the theoretical deductions.

The finding of that the evolutionary properties of the pulsars – from simple to complex – are related to the period[11] is further evidence in support of the theoretical conclusion that the period is a function of the age. These observers classify the pulsars into three groups, those in which the pulse shape is simple, those in which it is complex, and an intermediate group. All of the pulsars of the simple type have periods less than one second; all of the complex type have periods longer than one second. Complex pulsation periods will theoretically

develop as the pulsar overcomes the gravitational retardation and gets up to full speed, for the same reasons that apply to the development of complex radio structure in the quasars. The double-peaked pulse (double temporal structure) that is typical of pulsars with periods greater than one second is analogous to the double spatial structure of the quasar radio emission (See *Quasars – Three Years Later*).

It will be appropriate to close the discussion of the compact x-ray sources by checking the theoretical findings outlined in the foregoing pages against G. R. Burbidge's itemization of "What we need to explain."[5] His list is as follows:

1. The great power of the sources.
2. Rapid and complex variability.
3. Binary character.
4. Rarity of powerful x-ray sources compared with the number of close binaries.
5. Non-thermal radio emission from two x-ray sources and non x-ray binaries.

All of these features are explained by the RS theory. The following comments may be made with respect to the individual items:

1. Strong radioactive emission from masses of stellar magnitude is obviously sufficient to explain both the x-ray and the radio power.
2. Emission from constantly changing groups of isotopes with half-lives all the way from seconds to years accounts for both the rapidity and the complexity of the variation. Where a single event (a "burst") can be identified, the decay follows the normal exponential pattern of radioactivity, a pattern which, is "incompatible with the usual models."[12]
3. According to the theory, *all* of the compact galactic x-ray sources are white dwarfs or pulsars. These are the high speed products of Type I and Type II supernova explosions, respectively. The low speed products of these explosions ultimately consolidate into stars, and form binary systems with the white dwarfs and those of the pulsars that return to the low speed region. The theory thus requires all of the compact x-ray emitters to be members of binary systems.

4. This is simply a matter of the comparative amount of time spent in the respective stages. The x-ray emitting period in the life of a white dwarf is very short.
5. All x-ray emitters are radio emitters earlier, and produce x-rays in a later stage when they lose the ultra-high speed that was the cause of the radio emission. But the speeds of the individual atoms in the aggregates are distributed over a wide range, and there is some x-ray emission from the radio aggregates, and some radio emission from the x-ray aggregates. When the speed of the aggregate is near the boundary line, the amount of the deviant radiation may be substantial. As noted in the discussion of the Crab pulsar, it is also possible for the outer portion of a compact aggregate to revert to low speed and begin emitting x-rays, while the material in the interior is still radiating strongly at radio frequencies.

The RS theory meets all of Burbidge's specifications fully and easily, not by a series of ad hoc constructions tailored to fit the observations, but by a purely deductive, and wholly inflexible, process of development of the consequences of the postulates as to the properties of *space and time* upon which the Reciprocal System of theory is based. If space and time do, in fact, have the postulated properties, then x-ray emission *must* take place from certain specific types of astronomical objects (the existence of which is required by the theory) in a particular stage of their existence, and the emission *must* have the particular characteristics that have been described.

Turning now to a consideration of the emission from the supernova remnants, we find that very little in the way of detailed information is available as yet. One point of interest is that much of the high frequency radiation from these objects appears to be coming from localized areas within the remnants, such as an x-ray "hot spot" that has been reported in the center of the Cygnus Loop. Concentrations of this kind are natural results of the theoretical process that produces the emission, as some of the material in the intermediate range of speed – above unity, but below the escape speed – can be expected to form local aggregates: miniature white dwarfs, we may say. If this kind of material is more widely dispersed in the form of

diffuse clouds of matter, it will be subject to the same processes, but will then manifest itself in the form of extended sources of x-ray emission, many of which have been reported by the observers.

The remnants provide an opportunity for observing the older x-ray emissions, which differ significantly from those of more recent origin. As is evident on examination of the properties of the common isotopes of the elements, the more distant the isotope is from the center of the zone of stability, the more energetic the radiation, and the shorter the half-life, on the average. Consequently, the original "hard", or energetic, x-rays from matter dropping back into the low speed range becomes softer as time goes on and the short-lived isotopes are eliminated. As indicated in the discussion in the preceding pages, the x-ray emission from the compact sources is cut off at a rather early stage by accretion of an outer shell of low speed matter, and according to the theory, the remnants are the only sources that are old enough to have eliminated most of the hard component. This theoretical conclusion is in full agreement with the observations. There is no evidence of the existence of any source, aside from the older remnants, that emits only x-rays below 1 keV energy.[1]

The compact x-ray sources are either "exceedingly rare or represent short-lived x-ray emitting phases in stellar evolution." The theoretical identification of the soft x-rays with age, and the evidence from the remnants that ages of 25,000 to 50,000 years are sufficient to reduce the emission to the soft status, show that the second alternative is the correct one. The production of x-rays in the interiors of the white dwarfs continues until all of the ultra-high speed matter has reverted to low speeds – a process that requires a billion years or more but this radiation escapes from the surface of such a star only under special circumstances of short duration.

The correlation of x-ray energy with age enables differentiating between the emission from remnants and that originating in compact sources associated with, or contiguous to, the remnants. For example, where a pulsar originates in a remnant, or returns to a remnant after reversing its direction of motion, the observed x-ray emission will consist of two dissimilar components. That from the pulsar, initiated relatively recently in either of the two situations mentioned, will be more energetic (harder) than the emission from

the remnants, which dates back almost to the original supernova explosion. The two components can therefore be distinguished on this basis. Such an identification has already been made in the case of Hercules X-l, and the ability to differentiate between the emissions from different sources will no doubt be helpful in overcoming some of the difficulty that has been experienced in determining the nature of other x-ray sources.

It has been reported that there is no remnant at the Hercules location, but, of course, this merely means that no optical evidence of a remnant has been detected. As noted in Quasars and Pulsars, a large proportion of the total mass of the star that explodes in a Type II supernova goes into the high speed product, and since this material is not optically visible, there are many relatively young remnants that cannot be identified optically until some later date when they have lost enough energy to bring a substantial part of the ultra-high speed matter back into the low speed (visible) range. The existence of so much invisible matter in the remnants, and its slow reversion to the lower speeds, with the accompanying radioactivity, also explains the variability, the long duration, and the large total amount of the energy release in the Type II remnants, an amount which, as some observers have commented, appears, in many cases, to be inconsistent with the visible state of the remnants.

Somewhat similar "remnants", as well as compact sources of radiation, will also be formed as a result of explosive events in the galaxies, not only the violent explosions that eject the quasars, but also the emission of jets of material from galaxies such as M 87, and the more widely dispersed ejections from the Seyfert and other intermediate type galaxies. The galactic explosions differ from the supernovae not only in size, but also in some other respects, particularly in that they hurl their products outward, giving them a spatial motion, whereas the high speed product of a supernova – a white dwarf or a pulsar – remains at the spatial site of the explosion unless that explosion is, for some reason, asymmetrical. Also, the products of the galactic explosions are subject to powerful gravitational forces, whereas the gravitational retardation of the supernova products is relatively minor. Because of these differences in the controlling factors, the extra-galactic x-ray sources do

not follow a systematic pattern, in the manner of their galactic counterparts. Their distribution is essentially random, except that emission from diffuse matter (extended sources) is concentrated enough to be observable only while this matter is still in the general vicinity of the galaxy or galaxies from which it was expelled.

Unquestionably, the most important fact thus far disclosed by x-ray observations of the supernova remnants is simply the *existence* of the strong emission from these sources. There is no obvious or *a priori* reason why such remnants should necessarily emit x-rays, or, for that matter, why *any* astronomical object should emit x-rays. "The discovery of cosmic x-rays was totally unexpected", says R. J. Gould.[13] Current astronomical thought is still groping for an explanation of the conditions under which the emission takes place, and the mechanism by which the x-rays are produced. As expressed by G. R. Burbidge in the reference previously cited, "We don't really know... how the basic radiation mechanisms operate and are maintained."[5] The symposium report mentioned earlier includes this statement:

> Most of the known, realistic mechanisms for the generation of x-rays lead to somewhat complicated theoretical statements, and the number of adjustable parameters is often too great for comfort.[1]

The special significance of the emission from the supernova remnants is that, unless we make the rather far-fetched assumption that there are *two* processes by which astronomical objects produce x-rays in immense, totally unprecedented, quantities, the emission mechanism must be one that is applicable to *both* of the observed types of galactic sources: highly condensed stars and supernova remnants. This not only rules out the currently popular speculations that invoke the hypothetical properties of hypothetical entities such as neutron stars and black holes, but also imposes some severe constraints on the kind of a process that can be given serious consideration.

Furthermore, when the observed emission of x-rays from the *remnants* of the supernovae is considered in conjunction with the results of the observations that have sought, but failed to detect, high frequency radiation in significant amounts from the supernovae, a still more rigid requirement is imposed on astronomical x-ray theory. The fact that emission occurs both from concentrations of matter (hot

spots) and from diffuse clouds (extended sources) in the remnants means that the emission must result from the condition of the matter itself, not from the nature of the aggregate. But the absence of high frequency radiation during the observable stage of the supernova explosion, when the particle energies are at a maximum, shows that temperature alone is not the answer, and that thermal processes are not, in themselves, adequate to account for the strong x-ray emission.

In the remnants (and in the other sources as well, if those sources are products of supernovae, as generally believed) the emission comes from matter which has been losing energy – for 50,000 years or more in some cases – and is now at an energy level far below the peak reached in the explosion. The observations thus require the existence of a process in which matter that *loses* a portion of its energy *after* having reached explosive energy levels undergoes some change that involves emission of x-rays. Conventional theory knows of no such process, but according to the RS theory, this is just exactly what takes place in the explosion products of intermediate energy.

When it is realized that a satisfactory theory not only has to meet these rigid requirements of a general nature, but also has to provide an explanation of the existence of "x-ray novae", a reason why the compact x-ray sources occur (so far as we can tell) only in binary systems, why some emissions are pulsed and some are not, and other such details, it is clear that this presents a formidable challenge to any theory of the phenomena that is proposed. It should not be surprising, therefore, that conventional astronomical theory is unable to cope with the situation. The discoveries of the past quarter of a century, including the x-ray phenomena, have taken astronomy into a totally new field, one in which it is evident, from the kind of difficulties that are being encountered, that some of the assumptions upon which conventional theory is based are not valid. Identification of the required modifications from within the system – that is, by reasoning from astronomical premises – encounters almost insuperable obstacles, and at many points progress toward understanding is at a standstill. Current literature is full of expressions such as "ever-deepening mystery," "baffling problem," "strange and inexplicable," and so on.

By deriving the basic astronomical relationships from general

physical premises, totally independent of astronomical observations or theories, the Reciprocal System of theory now provides what is needed: identification of the features of existing thought that must be replaced or modified. This new development is a *general* physical theory, based entirely on some far-reaching assumptions as to the nature of *space and time,* and originally derived from a critical study of the physical and chemical properties of matter. It applies to astronomical phenomena, as well as to the more general physical relations, because all astronomical objects are also physical objects, subject to the general physical laws.

An impressive feature of the results of the application of this RS theory (one that is to be expected, but is no less impressive for that reason) is the way in which the simplification of the basic premises – deriving *all* conclusions from the *same* set of assumptions – accomplishes a drastic simplification of the processes that take place in the astronomical phenomena that are involved in the present discussion. In the context of the RS theory, *all* of the compact, high density astronomical objects – quasars, pulsars, observable white dwarfs, x-ray sources, etc. – originate in the *same* manner (as the result of explosions). The extremely high density of *all* of these objects is due to the *same* cause (ultra-high speeds imparted by the explosions). The strong radiation – radio and x-ray – observed from these sources in certain periods of their existence results in *all* cases from the *same* process (isotopic adjustment necessitated when matter goes from low speed to ultra-high speed, or vice versa). As shown in the description of the theoretical development in this and previous publications, the differences between the various explosion products, and their behavior, can be accounted for, in full detail, by the conditions under which they are produced, and under which they currently exist: the character and power of the explosions, the nature of the environment, etc.

Of course, a few cherished ideas of long standing must be sacrificed in order to enable accepting the premises of the new theory, but on careful consideration it will be found that there is no real sacrifice involved; that what has to be given up is only the *form* in which these ideas are currently expressed. Where there is real merit, the RS theory preserves the substance in a different form.

From the new theoretical development we find that the "mysterious" and "baffling" objects and events which the astronomers have recently discovered, and are now trying to understand, are ultra-high speed phenomena, in which the familiar physical relationships are inverted because the objects to which they apply are moving with speeds in excess of unity, the speed of light. The most important modification of conventional thought that is required by the Reciprocal System is therefore the elimination of the limitation on speed imposed by Einstein's theory of motion at high velocities. The immediate reaction of most scientists is that this is unthinkable; that the validity of Einstein's relationships has been demonstrated in countless experiments and applications, and that tinkering with them would lead to chaos in the high velocity field. But this is just another illustration of the way in which unsupported assertions acquire the standing of incontrovertible facts simply by virtue of long-continued repetition. The truth is that all of the achievements of Einstein's theory – the agreement with experiment, the successful use of the theory in the design and operation of particle accelerators, etc. – are *mathematical*. What these results demonstrate is that the theory is mathematically correct. But the limitation on speed does not come from the mathematics; it comes from Einstein's explanation of the mathematics.

Contrary to popular belief, this explanation, the *conceptual* aspect of Einstein's theory of motion at high velocities, has never been verified in any manner. Furthermore, it has the weakest possible kind of a foundation; it rests entirely on a pure *assumption*. The *fact* disclosed by experiment, and verified in practical application, is that when a presumably constant force of electromagnetic origin is applied to the acceleration of a presumably constant mass, the acceleration does not remain constant, as required by the definition of force, F=ma, but decreases at high speeds and approaches zero at the speed of light. This means that one of the presumably constant quantities is not a constant, but a variable. As most elementary physics textbooks point out, the mathematics are exactly the same whether the variable quantity is the mass or the force, and there is no physical evidence to indicate where the variation takes place. In the absence of such evidence, Einstein had to make an assumption, and he chose to build his theory – his *explanation* of the mathematical relations – on the basis of a variable mass. Development of the RS theory now indicates that he made the

wrong choice, and that the variable quantity is actually the force; that is, instead of the mass approaching infinity as the speed approaches unity (the speed of light), the effective force approaches zero.

The significance of this difference in the interpretation of the mathematical relations is that if the *mass* were the variable quantity, as Einstein assumed, the limitation would apply to the speed. It would then be impossible to exceed the speed of light. But if the *force* is the variable quantity, in accordance with the conclusions of the RS theory, then the limitation is on the capabilities of the process; that is, the physical evidence then shows that it is impossible to produce a speed in excess of that of light by electromagnetic means. Such a limitation on the capability of one process does not preclude acceleration of a mass to a higher speed by some other process – by an explosion, for example. Replacement of Einstein's arbitrary selection from among the two possible interpretations of the mathematical pattern with the interpretation *derived theoretically* from the postulates of the Reciprocal System thus opens up the entire range of speeds beyond the speed of light *without altering any of the mathematics now being used in application to motion at speeds less than that of light.*

This is a good example of the way in which the Reciprocal System of theory accomplishes the objective of eliminating the errors and misconceptions of conventional theory without disturbing its valid and useful features. Of course, this is just what a correct general physical theory *must* do. The essential elements of existing theories are empirical. These theories agree with observations, and particularly with the observed mathematical relations, because they were designed specifically for this purpose. A valid general theory must also agree with the observations and measurements, and it must therefore arrive at these same results. But if a theory is to be anything more than a description of the observations, it must provide an *interpretation* of the observed facts, and this is where so many theories go wrong, as there is usually very little of a solid nature on which the theorist can rely for guidance. As expressed by Sir James Jeans:

> The history of theoretical physics is a record of the clothing of mathematical formulae which were right, or very nearly right, with physical interpretations which were often very badly wrong.[14]

There is a tendency on the part of each new generation of scientists to assume that "things are different now", and that the surmises and conjectures involved in the current interpretations of observations and measurements are somehow free from errors of the kind that have been so prevalent in the past. But it should not require any great perspicacity to enable realizing that as long as any kind of guesswork enters into the construction of theories, mistakes will be made. The question that now confronts us is not *whether* there are errors in current astronomical thought, but *where* the errors are. This is the question that the Reciprocal System of theory is now ready to answer.

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CHAPTER 13

The Mechanism of the Universe

The human race, in its modern form, has been observing the universe from the surface of this planet for something like 50,000 years, perhaps as much as 100,000. But only within the last three or four thousand years has it had the capacity to analyze these observations and arrive at conclusions as to their significance. Yet on the basis of this extremely limited experience we somehow feel that we are competent to investigate events which, if they happened at all, happened ten or twenty billion years ago, and other events which, if they are ever going to happen, will not happen for an equally long time into the future.

This highly presumptuous undertaking, which goes by the name of cosmology, has thus far been left mainly in the hands of two special groups: the astronomers, who are the only ones that deal with objects and processes that persist over long enough periods of time to throw any light on the points at issue, and the theologians, who are the only ones that claim to have sources of information independent of experience. Since our discussion will be concerned with the scientific aspects of the subject, it will not be feasible to give any consideration to the religious contentions and to the non-scientific evidence that is offered in support of those contentions. It will be appropriate, however, to take a brief look at the information from which the astronomers are deriving their theories.

From the planets, particularly the one that we know best, the one on which we live, we obtain one very significant item of information. It is now clear that the earth is undergoing some changes of an irreversible nature—what we rather loosely call evolutionary processes. This point may not seem very significant, as it is now taken for granted. One should bear in mind, however, that it was

not always taken for granted. On the contrary, during almost all of the history of the human race the belief was that both the earth and the heavens are fixed and unchanging. The definite evidence of the existence of irreversible processes on the earth is important because it is positive proof that the universe is not fixed and immutable; it is a universe of change.

Another result of the studies that have been made of our own planet is an indication of the time scale of events in the universe. By extrapolating the rates of some of the irreversible changes, such as radioactive disintegration, back to some assumed base condition, it has been found that there was a discontinuity of some kind about four or five billion years ago. This has been interpreted as representing the time of formation of the earth. Here, however, we encounter something that we need to watch out for, whenever we are attempting to assess the validity of scientific conclusions. If we examine the nature of the argument in this case, we find that the conclusions do not follow logically from the premises. Radioactivity is not a property of the earth as an aggregate; it is a property of the radioactive matter. If the calculated zero point indicates an age, it therefore indicates the age of the matter, not the age of the earth. This conclusion is not acceptable to present-day scientists, so they substitute one that is more to their liking. We should disregard it, and recognize that the observations actually tell us nothing beyond the fact that there was a discontinuity of some kind four or five billion years ago. For present purposes, that is sufficient, as it establishes the fact that we are dealing with objects and processes that persist through billions of years.

The definite knowledge that this is a universe of change becomes very important when we move from planets to stars, because there is little opportunity for direct observation of the changes that are taking place there. The time scale of astronomical events is so long that our observations give us little more than an instantaneous picture. But there are aspects of this picture that suggest change, and the knowledge that changes do take place justifies us in concluding, at least tentatively, that the indications of change are not misleading. However, our ideas as to the nature and directions of the changes have to be based mainly on assumption and inference. For example,

stars come in a great variety of sizes and temperatures, but the great majority of them can be placed in a regular pattern known as the main sequence. In a universe of change there is good reason to believe that this is an evolutionary pattern of some kind, but unfortunately the pattern itself gives us no clue as to the direction of the evolution. It does not tell us which are the old stars and which the young. For an answer to this question we must examine some collateral data.

When we attempt to do so, however, we encounter one of the major problems of astronomy, and the astronomical view of cosmology. These collateral items to which we turn for a resolution of the question do not agree. In fact, as I will bring out later in the discussion, most of the purely astronomical evidence contradicts the prevailing astronomical opinion. What has happened here is that a very tentative conclusion as to the source of the energy of the stars that has been reached by the physicists has been accepted by the astronomers as incontestable, and has been allowed to override the astronomical evidence. The physicists have spoken; let no dog howl.

This is an example of another of the things we have to guard against when we undertake a critical examination of any field of knowledge: a tendency to magnify the observational information in transmission between the isolated compartments in which today's specialists work. The physicists know that their conclusions in this case are far from secure, and it is probable that those conclusions would be thrown overboard quickly if it developed that they were in conflict with any physical information, but by the time they have been passed on to the astronomers they have acquired the status of Holy Writ, and any doubt as to their validity is unthinkable.

A similar process of enhancement takes place whenever highly questionable assumptions are subjected to advanced mathematical treatment. By the time the original data have been put through a half dozen esoteric mathematical processes and an answer of some kind has been obtained, it is all too often forgotten that the whole construction rests on nothing but the thin air of an assumption. I am emphasizing these points because the biggest obstacle that stands in the way of arriving at an understanding of the remote regions and features of the universe is the existence of so many errors and misconceptions in what currently passes as knowledge. As one

American humorist put it, some years ago, "It isn't what we don't know that hurts us; it is what we do know that ain't so."

In addition to the information that we get from the stars individually, the observations of stellar groups, clusters, as we call them, provide some further clues as to the nature of the evolutionary processes in which they are participating. Indeed, the clusters have been more informative on the subject of the direction of evolution of the stars than the stars themselves. Here again, however, it is by no means certain how the observational information should be interpreted, and consequently its significance has been open to serious question.

When we step up to the next larger aggregates of matter, the galaxies, we again find some similar patterns that shed some light on the cosmological question. This completes the astronomical contribution to the solution of the problem, aside from one new factor that has come to light very recently. But strangely enough, these astronomical observations, which constituted the entire basis for cosmological speculation until a few years ago, are now almost totally disregarded. Current cosmological theories make no attempt to connect the evolution of the contents of the universe – the galaxies, the clusters, the stars, the planets, the independent particles, and the non-material constituents – with the evolution of the universe as a whole.

The recent findings on which cosmological attention is now concentrated are those which show that the wavelengths of the radiation received from the distant galaxies are strongly shifted toward the red end of the spectrum. If these red-shifts are interpreted as Doppler shifts, the only adequate explanation that is currently available, the distant galaxies are receding from us at extremely high velocities which increase linearly with the distance. This indicates that the entire universe is undergoing a process of expansion. Obviously any cosmological theory must provide some kind of an explanation for the expansion, as it is clearly a significant feature of the cosmological pattern. As matters now stand, however, the cosmologists are concentrating their attention almost entirely on this one phenomenon, as if it were the whole problem. It would not be too far from the truth to say that the current theories of cosmology are nothing more than theories of the galactic recession.

If scientific questions were settled by majority vote, the winner in the cosmological race at the present time would be what is rather irreverently called the Big Bang theory. This theory accounts for the recession by extrapolating the observed rate of recession back to zero and assuming that at the time thus calculated, some ten or twenty billion years ago, all, or most, of the matter in the universe was contained in one dense mass, which, for some reason, exploded and ejected its contents at the high velocities that we now observe. The ultimate fate of the universe, on this basis, will be a situation in which all activity will cease because the constituents of the universe will be too widely dispersed to interact.

A variation of the Big Bang theory assumes that the forces of gravitation will ultimately overcome the outward motion, and will initiate a contraction that will terminate when the maximum density is again reached, whereupon a new Big Bang will occur. This oscillating theory visualizes a continual series of such cycles without a beginning or an end.

In the Steady State theory, the effect of the recession in moving the galaxies apart is offset by the continuous creation of new matter which forms new galaxies to fill in the vacant spaces resulting from the expansion, so that the universe, while always changing, always remains essentially the same.

All of these theories are subject to serious objections. The Big Bang is the least open to specific charges of error or inconsistency, but this is mainly because the theory consists almost entirely of untestable ad hoc assumptions. Of course, this is, in itself, a serious defect in the theory. The oscillating theory is subject to the same objections as the Big Bang theory, with the additional complication that it requires gravitation to be strong enough to eventually overcome the recession, whereas the indications are that the gravitational force is much too weak.

The strongest theoretical objection to the Steady State theory comes from those who are unwilling to sacrifice the conservation laws by admitting the continuous creation of matter that this theory requires. The history of the theory has been one of alternating rise and fall as additional evidence has accumulated. At the moment its fortunes are at a low ebb because of two recent developments of an

adverse nature. The first of these comes from investigations of the relation of the number of astronomical radio sources to the distance. On the basis of these radio source counts it is now believed that the universe was more densely populated some billions of years ago than at present. This, if correct, would rule out the Steady State theory. Another item that is currently being given much weight is the discovery of an isotopic background radiation that is more or less consistent with the Big Bang and oscillating theories but is as yet unexplained by the Steady State theory.

Neither of these new findings is at all conclusive, so far as the validity of either theory is concerned. The radio source counts are open to serious question, particularly since no one knows with any degree of certainty just what kind of objects are being counted. Likewise, the possibility of an explanation of the background radiation that is consistent with the Steady State theory is by no means excluded. Nor is the explanation of the cosmic background radiation in terms of the Big Bang theory as good as is claimed; it is now conveniently forgotten that the temperature of the background originally predicted by the Big Bang cosmologists was significantly higher than the observed value. In any event, it should be recognized that disproof of one theory is not equivalent to proof of another. Even if the new observations are accepted at their face value, they contribute nothing toward establishing the validity of the central assertion of the Big Bang theory: the assertion that the recession of the galaxies is due to a primeval explosion.

This is the cosmological situation at the moment. For an overall appraisal of just how matters now stand I will quote two prominent scientists:

> This job—cosmology—starts with rigorous analysis and ends in flights of imagination.
>
> –Vannevar Bush)

> All chains of reasoning in cosmology are elastic. Almost every observation interpreted to support one conclusion can, in the hands of a moderately adroit theoretician, be interpreted to support the opposite.
>
> —Irwin I. Shapiro)

I am going to present a look at this situation from a new direction. This new view will not utilize any of the information that the astronomers have gathered from their observations. Where I refer to this information at all, it will be only for purposes of comparison with the results that have been obtained theoretically. Nor will I make any use of the information that the ecclesiastics claim to have received through revelation of one kind or another. Instead, I will present a view that is derived entirely by deduction from basic physical premises. This view is now open to us because we have at our disposal a general physical theory—the theory of the universe of motion.

The most primitive condition in a universe of motion, the condition in which the universe is in existence, but nothing at all is happening, is one in which nothing exists but independent units of motion. Each such unit involves one unit of space in association with one unit of time, and the speed is therefore 1/1 or unity. This means that the physical datum, or reference level, on the natural basis, the basis to which the universe actually conforms, is not the mathematical zero, but unit speed.

Let us consider an object which has no capability of independent motion, and is not acted upon by any outside force. If this object occupies a spatial location, which we may call s, at some time t, then, since it cannot move, it must remain at the same location indefinitely. But in a universe of motion this object is not motionless with respect to the arbitrary stationary system of reference that we customarily utilize—it is motionless with respect to the natural system of reference. That natural system is moving outward at unit speed with respect to the stationary system, carrying all physical objects with it. Thus, the object in question does not remain at the point in a stationary reference system which we have called s. It moves outward from that location at unit speed, so that at time t+l it occupies spatial location s+l.

Some may find this difficult to reconcile with their present beliefs. We are accustomed to viewing motion in the context of its relation to a stationary spatial frame of reference. If an object has no capability of independent motion, then it seems almost axiomatic to most that its speed is zero with respect to that stationary reference frame. But

there is no good reason why the universe must necessarily conform to human ideas as to what is right and proper. The general physical theory that we have developed, a theory that describes how the universe actually behaves, not what any of us thinks is the way it ought to behave, tells us that, in addition to whatever other motions it may possess, every object in the universe is moving outward at unit speed away from all other objects, simply by reason of the motion of the natural reference system relative to the stationary system that we have arbitrarily selected as a frame of reference.

Here we have a very important conclusion that, as I have shown, is derived purely by deduction from the general properties of a universe of motion. It will not be possible to follow the lines or chains of deductions leading to other conclusions in this same detailed manner on this occasion. For present purposes I will merely indicate the points at which we will have to go back to the basic premises and follow a new chain of deductions, and I will specify the conclusions that are thus reached, to the extent that they are relevant to the subjects under discussion. The full details of the theoretical development are available in my publications and those of my associates.

One of these additional lines of deductions from the basic premises arrives at the conclusion that atoms of matter are combinations of rotational motions, and that the nature of these atomic rotations is such that they have a translational aspect. As an analogy, we may consider a ball rolling along the floor. This ball does not have an independent translational motion, as it would if it were flying through the air while rotating. It has no motion other than the rotation, but the effect of this rotation, under the particular circumstances, is to move the ball forward translationally. A further finding from the same chain of deductions is that the translational motion due to the atomic rotation necessarily opposes the outward progression of the natural reference system. Thus, in addition to the outward motion due to this progression, every atom or aggregate of matter is subject to an opposing inward motion. This inward motion is what we know as gravitation.

It has long been recognized that there are many physical phenomena that are not capable of satisfactory explanation on the

basis of the only universal force (or motion, which is another way of looking at the same thing) that has heretofore been recognized; that is, gravitation. For example, Gold and Hoyle make this comment:

Attempts to explain both the expansion of the universe and the condensation of galaxies must be very largely contradictory so long as gravitation is the only force field under consideration. For if the expansive kinetic energy of matter is adequate to give universal expansion against the gravitational field it is adequate to prevent local condensation under gravity and vice versa. That is why, essentially, the formation of galaxies is passed over with little comment in most systems of cosmology.

Karl K. Darrow made the same point in connection with the question of interatomic equilibrium in the solid state, emphasizing that one force alone, whatever it may be, is not sufficient. There must also be what he called an "antagonist". Darrow went on to say, "This essential and powerful force has no name of its own. This is because it is usually described in words not conveying directly the notion of force." The globular star clusters provide still another example of the same kind. Like the formation of galaxies, this situation is "passed over with little comment" by the astronomers, but E. Finlay-Freundlich discussed it at length in a publication of the Royal Astronomical Society some years ago. He noted that gravitation is the only force available to the theorist, and on this basis, he says, "the main problem presented by the globular clusters is their very existence as finite systems."

Identification of the "antagonist" to gravitation, the outward progression of the natural reference system, not only resolves these specific problems, but also throws new light on many other physical situations. An important point in this connection is that the net resultant of the two opposing motions varies with the distance. The inward motion due to the atomic rotation originates at the specific locations occupied by material aggregates, and it therefore decreases with distance in accordance with the inverse square law. The outward progression of the reference system is effective everywhere. It follows that at the shorter distances the gravitational motion is the greater, and all objects continually move toward each other, unless

they are subjected to external forces. As the distance increases, the gravitational motion decreases, and at some point reaches equality with the outward motion of the reference system. Beyond this point the net motion is outward, increasing toward the speed of light as the gravitational effect is continually attenuated.

Here, in these immediate consequences of the concept of a universe of motion, we have an explanation of the recession of the galaxies that comes directly out of basic theory, and requires no ad hoc assumptions. But it should now be evident why I raised the question with respect to the current belief that the answer to the galactic recession is the answer to the whole cosmological problem. The explanation of the recession at which we have arrived does not solve the problem; it merely rules out the ad hoc assumptions that have been made, and thereby deepens the mystery. The ultimate fate of the receding galaxies is still a wide open question, and the origin of the galaxies is more of a problem than before. Continuous creation is inconsistent with the basic elements of the new theory, and the Big Bang concept is eliminated from consideration, as the recession has been identified as due to a different cause. But the galaxies that formerly occupied the regions just beyond the gravitational limits have moved away, and yet there is no additional vacant space. Where did the present occupants of these regions come from?

We can approach this question most conveniently in a sort of roundabout way. Another line of deductions from the basic postulates, an extension of the deductive chain from which we arrived at the nature of the atomic structure, discloses that this this atom is subject to an age limit. When an atom of matter arrives at the limiting age its rotational motion reverts to the translational status; that is, the atomic mass is converted to energy. A further line of deductions leads to the conclusion that most of the oldest matter accumulates in the interiors of the largest galaxies. The attainment of the age limit on a massive scale in one of these giant galaxies results in a tremendous explosion, which accelerates portions of the remaining mass of the galaxy to a speed in excess of the speed of light. The question then becomes, What happens to this fast-moving matter?

For an answer to this question we need to return to the fact previously deduced that space and time are the two reciprocal aspects of motion,

and nothing else. This means that the reciprocal relation is a general relation that is effective throughout the universe. An immediate consequence is that for every physical entity or phenomenon there necessarily exists another entity or phenomenon that is similar in all respects except that space and time are interchanged. The inversion may be only partial, applying to only one of the motions involved – the translational motion, for example – or it may apply to all of these motions. All of the familiar entities of our material universe are therefore duplicated in the inverse manner, which leads to the conclusion that what we have been regarding as the physical universe is actually only one half of the physical universe as a whole. There also exists an exact duplicate, differing only in that wherever space is involved in any of the phenomena of our material sector, the inverse, or cosmic sector, as we will call it, substitutes time. Where we have time, it has space.

The next question that naturally arises is, Where is this cosmic sector of the universe? Here we need to look at the speed magnitudes. As already brought out, the natural reference system is moving at unit speed, which we can easily identify as the speed of light. In our material sector the prevailing speeds are less than unity, and the result is motion in space. In the cosmic sector, where space and time are interchanged, the speed is greater than unity, and the result is motion in time: a change of location in three-dimensional time that is analogous to the changes of location in three-dimensional space that result from motion at speeds less than unity. Thus each of the structures of the cosmic sector—the cosmic stars, cosmic galaxies, etc. – is separated from us by a certain amount of time, just as there are spatial separations between our location and the various structures of the material sector.

We receive the same kinds of information from the cosmic sector that reach us from the distant regions of the material sector: (l) radiation, and (2) individual particles of matter. But gravitation in the material sector is a motion in space, and it produces aggregates in which the constituent atoms are contiguous in space but widely dispersed in time. The radiation received from such an aggregate is therefore highly concentrated in space, and since we are approximately at rest in space relative to the emitting aggregate, we can recognize the

radiation as coming from a discrete object. However, gravitation in the cosmic sector is a motion in time, and it produces aggregates in which the constituent atoms are contiguous in time but widely dispersed in space. The radiation from these aggregates reaches us from the widely dispersed spatial locations, and instead of being concentrated in the manner-of radiation from a material star or galaxy, it is spatially isotropic. This is the background radiation that has been interpreted as evidence in favor of the Big Bang theory. We likewise encounter cosmic stars and galaxies from time to time, but because of the way in which their constituents are dispersed in space we encounter them as occasional single cosmic atoms rather than as aggregates.

At this point I must report, rather regretfully, that the Reciprocal System of theory is a great disappointment to the devotees of science fiction. Many of them are full of anticipation when they first hear that the theory involves motion in time, but their hopes are dashed when they find that time travel in a universe of motion is subject to exactly the same kind of limitations as space travel. If we have sufficient time at our disposal, we can always return to a specific location in space by means of space travel, but we cannot return to the same place at the same time: we can only get there at some later time. Similarly, by means of travel in time, it would be possible, in principle, to return to any time location, but we cannot return to the same time at the same place, we can only reach that time location at a distant place.

We likewise have to say no to anti-gravity devices. Superman will have to stay in the comic sections. Gravitation is a motion, and the only anti-gravity device is an opposing motion. Now I will have to deepen the gloom by consigning the anti-matter energy generators to the same discard pile. There are aggregates of anti-matter (or cosmic matter, as we prefer to call it) to be sure. There are anti-matter stars, clusters and galaxies. But these are aggregates in time, not in space, and we meet them only one atom at a time.

To make matters worse, we will also have to discard what we may call the sanctified science fiction, the many products of the imagination ranging from the fanciful to the fantastic that have

been injected into conventional physical and astronomical theory by investigators and theorists who have been frustrated in their attempts to solve their problems in an orderly scientific manner. Such ad hoc concepts as black holes, quarks, the Big Bang, curved space, etc., are no more scientific than anti-gravity devices. They have no place in the new system. In fact, this system outlaws ad hoc assumptions altogether.

Returning to cosmology, we now have the answer to the question as to the fate of the galactic fragments thrown off at speeds greater than the speed of light by the explosion of the galaxy. These fragments are observable for a time until the effect of gravitation is overcome, after which they enter the cosmic sector, the region of speeds above unity, and the matter of which they are composed then becomes available for the building of cosmic galaxies. These galaxies recede from each other, they and their constituents age, just as the material galaxies and their constituents do, and eventually the oldest cosmic galaxies explode and eject fragments at speeds less than unity. The fragments enter the material sector and become available as the raw material from which new galaxies are formed.

This, then, is the answer for which cosmology has been looking. As the proponents of the Steady State theory have contended, the universe had no beginning, and it will have no end. It has always existed in essentially the same form, and it has essentially the same appearance from any point in space or any point in time. But there is no continuous creation, nor do the galaxies simply disappear over the "time horizon," as in the Steady State theory. In a universe of motion the large-scale action of that universe is a cyclic process. Each half of the universe goes through an evolutionary sequence that begins with the entrance of matter from the inverse sector, transforms this matter into compatible structures, gathers it into aggregates, separates the aggregates, and finally subjects them to phenomena that result in the ejection of matter back into the inverse sector. A similar process in that sector completes the cycle.

For the benefit of those who may be reluctant to accept the idea of a universe without beginning or end because of a conflict with the religious idea of an act of creation, I will say that our findings

do not affect the creation issue one way or the other. If the universe of motion came into being through an act of creation, then space and time were the entities that were created. There could be nothing before time existed, and if it came into existence as a result of an act of creation, the universe that was created could just as well be cyclic as open-ended.

Having established the general nature of the cosmic cycle, let us now take a closer look at its principal features. One of the advantages of a general physical theory is that the deductions we make from it do not have to be confined to generalities. We can go into as much detail as we wish, or, in this case, as much as we have room for. The matter ejected from the cosmic sector arrives in the material sector in the form of atoms of the cosmic elements, together with sub-atomic particles. The current belief is that these incoming particles, the cosmic rays as they are called, are atoms of the material elements, but the available means of identifying the original cosmic rays are not capable of distinguishing between the cosmic and material atoms. Furthermore, the subsequent behavior of these particles shows that they are not ordinary material elements. If they were, they would maintain their identities at least until they made some violent contact with other matter. But this is not what happens. If these atoms do not make contact quickly, they disintegrate spontaneously.

This is not the place to give a detailed account of the complex process by which the cosmic elements are transformed into structures that are compatible with the material environment. I will merely say that the end product is hydrogen, and this new hydrogen is the raw material from which the new structures of the material sector are built.

It is recognized by the astronomers that any evolutionary theory of the universe must regard the aggregates of matter such as stars and galaxies as having been formed by condensation from dispersed matter. But just how this can take place is a difficult question that, as Gold and Hoyle pointed out in the statement that I quoted earlier, they prefer to avoid. But the continual arrival of new supplies of hydrogen derived by modification of the cosmic matter received from the cosmic sector provides the answer to this problem.

Let us consider a spherical volume of space containing a uniform

distribution of hydrogen atoms and sub-atomic particles. These particles, small as they are, are subject to the same two basic forces, or motions, that account for the translational behavior of the galaxies. The outward progression of the reference system carries each particle away from all others, while at the same time the gravitational motion carries all of them inward toward each other. The outermost particles of this spherical volume of matter are subject to the gravitational effect of the entire mass, as well as the interactions with their immediate neighbors, but in relatively small volumes the progression still predominates, and the aggregate tends to expand. As larger and larger volumes are taken into consideration, however, the mass, and consequently the total inward force, increases as the third power of the radius, whereas the effect of distance is a second power function. At some very large volume, therefore, the total gravitational motion of the outer particles exceeds the progression, and the entire aggregate of diffuse matter arrives at an equilibrium between the inward and outward motions.

Such an aggregate still has no unbalanced force that would cause it to contract, but the continual introduction of additional matter from the cosmic sector changes the situation, inasmuch as it strengthens the gravitational forces and moves the equilibrium inward. As this contraction of the volume occupied by the aggregate continues, and the density of the enclosed matter increases, local aggregates begin to build up within the occupied volume, and the ultimate result is a globular cluster, in which a million or more stars form a spherical aggregate.

The globular clusters have been an astronomical puzzle of long standing, as it is quite evident that they are stable and long-lived structures, but no adequate explanation has been available as to why the gravitational forces that hold such a cluster together do not cause its constituent stars to coalesce into one single mass. The progression of the natural reference system supplies the answer to this problem. The globular cluster is still subject to the same considerations as the spherical aggregate of diffuse matter from which it was formed. Like the interior particles of the diffuse aggregate, each of the stars in the interior of the cluster has a net outward motion. But the outer stars have net inward motions, and an equilibrium is established between these inward and outward motions.

The region under the gravitational control of a star within the cluster meets the region under the control of its neighbor at a point where the gravitational force of each star is near the minimum. Each star is therefore outside the gravitational limit of its neighbor, and because its net balance of motions is outward, it can never get inside this limit. The diffuse aggregate from which the globular cluster was formed contacts its neighbor at a point of maximum gravitational force, and the gravitational limits of neighboring aggregates therefore overlap. The increase of mass due to the incoming cosmic matter extends the limits still farther, and by the time the globular cluster stage is reached, each cluster is well within the gravitational limits of one or more of its neighbors. The clusters therefore move toward each other, and eventually some of them make contact.

The prevailing opinion is that because of the immense distances between the stars, the stellar aggregates participating in such an encounter would pass through each other with no significant interaction. Our findings indicate that this view is incorrect. Inasmuch as the stars of the cluster occupy equilibrium positions, the aggregate has the general characteristics of a liquid, and the actual result of contact is an amalgamation of the clusters. The resulting combination, with a population of two or three million stars, is classified as a dwarf galaxy. Its larger mass, as compared to that of the original cluster, greatly increases its gravitational force and improves its ability to capture additional clusters. If it keeps out of the clutches of still larger galaxies, the small galaxy ultimately becomes a large galaxy.

This picture of the situation is in direct conflict with much of current astronomical thought. Although no consensus has been reached on the issue as to how, and under what circumstances, condensation from the original diffuse matter occurred, conventional theory regards the galaxies, rather than the globular clusters, as the original products of the condensation process, and views the globular clusters as very old features of the galaxies. According to our findings by deduction from fundamental physical theory, the stars of the globular clusters, instead of being the oldest of those that are optically visible to us, as conventional theory asserts, are the youngest of the observable stars. In view of this direct conflict, it would be of interest to

review the available evidence to see just how well each of these conflicting theories agrees with the information from observation. Unfortunately, the remaining space will not permit a detailed review of this kind, but I can say that I made a critical comparison of the two conflicting explanations of the status of the globular clusters a few years ago, in which I examined the assertions of each theory with respect to fifteen sets of facts which can be considered to represent practically all that is now known about the clusters.

In this investigation I found that conventional theory furnishes fully acceptable explanations for three of these fifteen items, partially satisfactory explanations for three more, unsatisfactory explanations for three items, no explanation at all for four items, and is definitely in conflict with the facts in two cases. The deductions from the postulates of the Reciprocal System, on the other hand, furnish full and detailed explanations for every one of these fifteen items. While, as I said, space does not permit a full discussion of these results, I am rather reluctant to make statements such as the foregoing without at least some substantiation, and I will therefore comment briefly on two of the items, to give an idea of the basis for my conclusions.

First, let us consider the motions of the clusters. In the words of Struve, they move "much as freely falling bodies attracted by the galactic center." Our theory says that this is exactly what they are and how they should move. Conventional theory is able to explain such motions only on the basis of some highly implausible assumptions.

As an illustration of another type of pertinent information, observations of the star clusters within the galactic disc show that these groups are not stable, and are disintegrating at a relatively rapid rate. The large number of such clusters now in existence in spite of the short indicated life means that some process of replenishment must be operative. Our theoretical development tells us that the supply is replenished by globular clusters which fall into the galaxy and break up. The astronomers have no explanation at all. Bok, for example, says "we do not pretend to know from where the galactic clusters come." He admits that it would be "tempting" to regard the globular clusters as the source of the replacements, but this would

challenge the physicists' conclusions as to the source of the stellar energy and, of course, that is unthinkable.

There is no limitation on the process of capture from the environment which continually increases the size of a galaxy. So far as the capture process itself is concerned, the growth could continue indefinitely. However, the existence of an age limit also limits the galactic size. When this limit is reached the material phase of the great cycle of the universe of motion terminates.

CHAPTER 14

A Note on Metaphysics

Some of the readers of this book may interpret its conclusions as indicating that the Reciprocal System of theory leads to a strict mechanistic view of the universe, in which there is no room for religious or other non-material elements. This is not correct. On the contrary, the clarification of the nature of space and time in this theoretical development removes the obstacles that have hitherto prevented science from conceding the existence of anything outside the boundaries of the physical realm.

In conventional science, space and time constitute a framework, or setting, within which the entire universe is contained. On the basis of this viewpoint, everything that exists, in a real sense, exists in space and in time. Scientists believe that the whole of this real universe is now within their field of observation, and they see no indication of anything non-physical. It follows that anyone who accepts the findings of conventional science at their face value cannot accept the claims of religion, or any other non-material system of thought. This is the origin of the long-standing antagonism between science and religion, a conflict which most scientists find it necessary to evade by keeping their religious beliefs separate from their scientific beliefs.

In the Reciprocal System, on the other hand, space and time are contents of the universe, rather than a container in which the universe exists. On this basis, the "universe" of space and time, the physical universe, to which conventional science is restricted, is only one portion of existence as a whole, the real "universe" (a word which means the total of all that exists). This leaves the door wide open for the existence of entities and phenomena outside (that is, independent of) the physical universe, as contended by the various religions and many systems of philosophy.

Inasmuch as the Reciprocal System is a theory of the physical universe only, it arrives at no conclusions as to the validity of the contentions of the various non-scientific schools of thought, but it removes all justification for the assertions that are frequently made to the effect that those contentions are scientifically impossible. Those scientists with strong religious convictions who are now looking askance at the Reciprocal System under the mistaken impression that it envisions a purely materialistic universe should, in fact, welcome it, because it removes the basic conflict between science and their religious beliefs.

The present volume is a collection of essays and lectures by Dewey B. Larson, arranged and adapted to serve as an introduction the the Reciprocal System of Theory that he originated. It fills a critical need, since those encountering the theory for the first time may feel overwhelmed by the novelty of its concepts and discouraged by its unfamiliar terminology.

Larson's lectures and articles have proved to be a rich mine for extracting the components of an introductory text, suitable for those encountering the Reciprocal System for the first time. Even those familar with Larson's major publications will find much of interest in it. Larson was an engaging speaker, and his recorded talks are both enlightening and enjoyable.

The book opens with a critique of the current state of physical theory and its methods, continues by laying a new foundation on which a general and consistent theory of physics can be built and cultimates with a stupendous exposition of the outer reaches of the physical universe and beyond.